CHAPTER 3.3

Biological Resources: Fisheries and Aquatic Habitat

This Chapter discusses the existing environment of the Shasta River watershed (Program Area) with regards to fisheries resources and aquatic habitat; identifies potential impacts on fisheries resources and aquatic habitat in the Shasta Valley related to the Shasta River Watershed-wide Permitting Program (Program); and proposes mitigation measures for those impacts determined to be significant. The Program Area supports one special-status[1] fish species, coho salmon (*Oncorhynchus kisutch*), and four CDFG fish species of special concern[2]: Chinook salmon (*O. tschawytscha*); steelhead (*O. mykiss*); Klamath River lamprey (*Lampetra similis*); and river lamprey (*L. ayresi*). Pacific lamprey (*L. tridentata*), although not officially a CDFG fish species of special concern, is treated as such for the purpose of this document. Other native fish species known to occur in the Shasta River watershed include western brook lamprey (*L. richardsoni*); Klamath smallscale sucker (*Catostomus rimiculus*); speckled dace (*Rhinichthys osculus*); and sculpins (*Cottus* spp.). However, particular attention in this Draft Environmental Impact Report (EIR) is given to coho salmon because: 1) coho salmon in the Program Area are listed as threatened under the California Endangered Species Act (CESA) and federal Endangered Species Act (ESA); 2) the Program is intended to provide incidental take authorization for coho salmon, pursuant to CESA, and to implement key coho salmon recovery projects; and 3) the other fish species identified above are dependent on a similar range of aquatic habitats as coho salmon. Hence, any impacts the Program could have on those aquatic habitats that could affect coho salmon, could also affect those other fish species, although the significance thresholds for those species are much higher.

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1 For the purpose of this document a "special-status species" is any species that meets the definition of "endangered, rare or threatened" in CEQA *Guidelines*, § 15380 (fully defined in the Glossary). Some CDFG species of special concern are special-status species. Such species are referred to as "special-status species" in this document.

2 "CDFG species of special concern" are those species that CDFG has determined are either declining at a rate that could result in listing or historically occurred in low numbers and known threats to their persistence currently exists (See the Glossary for a complete definition). Some CDFG species of special concern are "special status species" because they meet the definition of "endangered, rare, or threatened" in CEQA *Guidelines* § 15380. For the purpose of this document, CDFG species of special concern that are also special-status species are referred to as "special-status species", while CDFG species of special concern that are *not* also special-status species are referred to as "CDFG species of special concern."

3.3.1 Setting

Regional Setting

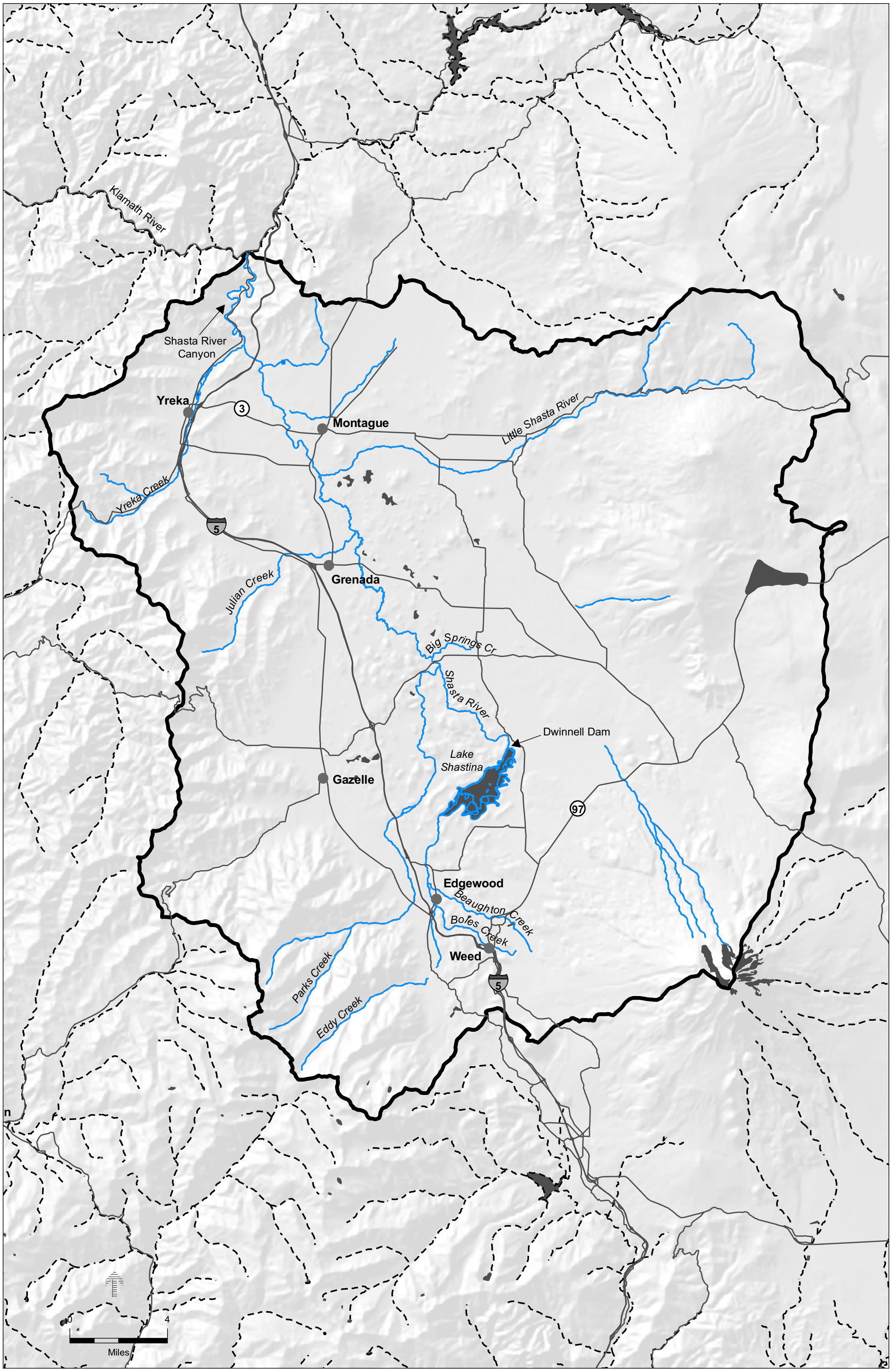
The Shasta River, located in Siskiyou County in Northern California, is one of four major tributaries to the Klamath River. The Klamath River is California's second largest river, draining approximately 15,600 square miles (of which 3,600 square miles are considered non-contributing) in California and Oregon with approximately 1,832 miles of waterways (Ayres and Associates, 1999; CDFG, 2004a). Major tributaries include the Trinity, Salmon, Scott, and Shasta Rivers. Numerous other tributaries enter the Klamath River along its length.

Past and ongoing agricultural and hydroelectric development and use of the water resources in the Klamath Basin have degraded the water quality of the Klamath River and its tributaries, reduced total annual discharge, and altered the magnitude, timing and duration of flow so that more water runs downstream in the Klamath River during winter months, and less during the spring and summer than occurred prior to such development. Problems facing anadromous salmonids, including coho salmon, include an altered hydrograph, high summer water temperatures, reduced and degraded habitat, lack of access to available habitat, erosion and sedimentation, degraded condition of riparian vegetation, depleted large woody debris (LWD), unscreened water diversions, legacy impacts from historical timber operations and mining, and agricultural conversion (CDFG, 2004a). Other water quality conditions, such as low dissolved oxygen concentrations, high nutrient loads, and toxic algae associated with reservoirs have also resulted in aquatic habitat degradations that include the prevalence of fish diseases and parasites.

One outcome of the impaired conditions in the Klamath River was a major adult salmonid mortality event that occurred in the fall of 2002. At least 33,000 adult salmonids died during mid- to late-September 2002 in the lower 36 miles of the river (CDFG, 2004b). Fall-run Chinook salmon were the primary species affected, but coho salmon, steelhead, and other fish species were also lost. The primary cause of the fish-kill was a disease epizootic (CDFG, 2004b). Several factors contributed to stressful conditions for fish, which ultimately led to the epizootic, including low river flow, an above-average number of Chinook salmon entering the Klamath River between the last week in August and the first week of September 2002, and a low volume of water in the fish-kill area. Fish passage may have been impeded by low-flow depths over certain riffles or a lack of cues for fish to migrate upstream. The high density of hosts and warm temperatures created ideal conditions for pathogens ichthyopthirius or "ich" (*Ichthyophthirius multifiliis*) and columnaris (*Flexibacter columnaris*) to infect salmon.

Shasta River Watershed

The Shasta River enters the Klamath at River Mile (RM) 177 at an elevation of approximately 2,000 feet and drains a watershed area of approximately 507,500 acres (793 square miles). Major tributaries to the 50-mile long Shasta River include Parks Creek, Big Springs Creek, Little Shasta River, and Yreka Creek (**Figure 3.3-1**). The river drains a portion of the Cascade Province to the east and a portion of the Klamath Province to the west.



SOURCE: ESA, 2007

Shasta River Watershed-Wide Permitting Program . 206063

Figure 3.3-1
Shasta River Watershed

The Shasta River originates in the Eddy Mountains and the watershed is bounded on the north by the Siskiyou Mountains, to the east by the Shasta-Cascades, to the west by the Klamath Mountains, and to the south by Mount Shasta and Black Butte. Located in the rain shadow of Mount Shasta and the Klamath range, the watershed experiences most of its precipitation in the southwest. Annual precipitation ranges from less than 15 inches in parts of the Valley to over 45 inches in the Eddy and Klamath Mountains, while precipitation on Mount Shasta ranges from 85 to 125 inches (WRCC, 2007; NCRWQCB, 2006). As relatively little precipitation falls on the floor of the Shasta Valley, the Shasta River receives the majority of its flow from glacial melting and mountain precipitation on Mount Shasta and the Eddy Mountains.

The Shasta River is an inland drainage with hot dry summers and cold, snowy winters. Summer temperatures may at times exceed 38ºC (100ºF) and average temperatures at Yreka range from approximately 20.5ºC (69ºF) in the summer to 2ºC (36ºF) during the winter. Vegetation in the watershed is diverse due to the variability in elevations, precipitation, and soil depths, and includes subalpine conifer, montane hardwood-conifer, rabbit brush, juniper, and montane riparian.

Further information on the Shasta River watershed hydrology, geomorphology, and water quality is provided in Chapter 3.2 of this Draft EIR and reach-specific aquatic habitat conditions are described below under *Aquatic Habitat Conditions and Utilization* in this Chapter.

Special-Status Fish Species and CDFG Fish Species of Special Concern

Aquatic habitats within the Program Area are known to support one special-status species, coho salmon, and five CDFG fish species of special concern; Chinook salmon; steelhead; river lamprey; Klamath River lamprey; and Pacific lamprey.[3] The status, life cycle, habitat requirements, and known population trends of these species are described below with particular emphasis on coho salmon as they are listed as threatened under CESA and ESA and a primary objective of the Program is to conserve and protect coho salmon.

Coho Salmon

Status

Coho salmon in the Klamath River watershed are part of the federally-designated Southern Oregon/Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU), which includes all coho salmon stocks between Cape Blanco in southern Oregon and Punta Gorda in northern California.

Based on its review of the status of coho salmon north of San Francisco, the California Department of Fish and Game (CDFG) (2002) concluded that California coho salmon have experienced a significant decline in the past 40 or 50 years. CDFG also concluded that coho

3 Although not officially a CDFG fish species of special concern, the Pacific lamprey is treated as such for the purposes of this Draft EIR.

salmon populations have been individually and cumulatively depleted or extirpated and that the natural linkages between individual populations have been fragmented or severed. For the California portion of the SONCC coho salmon ESU, an analysis of presence-by-brood-year data indicated that coho salmon now occupy about 61 percent of the streams that were previously identified by others (e.g., Brown and Moyle, 1991) as historical coho salmon streams (i.e., any stream for which published records of coho salmon presence could be found) (CDFG, 2002). However, these declines appeared to have occurred prior to the late 1980s and data available at the time of the CDFG (2002) analysis did not support a significant decline in distribution between the late 1980s and 2002. The analysis did indicate, however, that some streams in the ESU may have lost one or more brood year[4] lineages. Based on this information, CDFG concluded that coho salmon populations in the California portion of the SONCC ESU are threatened and will likely become endangered in the foreseeable future in the absence of special protection and management efforts required by CESA. In response to these findings, the Fish and Game Commission (Commission) adopted amendments to § 670.5 in title 14 of the California Code of Regulations on August 5, 2004, adding California coho salmon populations between Punta Gorda and the northern border of California to the list of threatened species under CESA, effective as of March 30, 2005 (Commission, 2004). The Commission had adopted the *Recovery Strategy for California Coho Salmon* (CDFG, 2004a) the previous year.

The National Marine Fisheries Service (NMFS) conducted a similar status review of the SONCC coho salmon populations in 1995 (Weitkamp et al., 1995). NMFS arrived at similar conclusions as CDFG regarding the likelihood that coho salmon in this ESU may become endangered in the foreseeable future if observed declines continue. NMFS listed the ESU as threatened under ESA on May 6, 1997, and designated critical habitat[5] for the ESU on May 5, 1999. The critical habitat designation encompasses accessible reaches of all streams and rivers within the range of SONCC coho salmon, including the Shasta River. Two subsequent NMFS status reviews in 2001 and 2005 essentially reaffirmed the prior conclusions (NMFS, 2001a; NMFS, 2005a) and the ESU continues to be listed as threatened (NMFS, 2005b). NMFS recently completed a recovery plan for coho salmon in the Klamath River basin (NMFS, 2007) and is currently preparing a recovery plan for the entire SONCC ESU.

Life Cycle

Adult coho salmon enter freshwater from the ocean in the fall in order to spawn. In the Klamath River watershed, coho salmon begin entering in early to mid-September and the migration reaches a peak in late September to early October. Arrival in the upper tributaries such as the Shasta River generally peaks in November and December. The majority of the coho salmon spawning activity in this area occurs mainly during these two months. Females usually choose

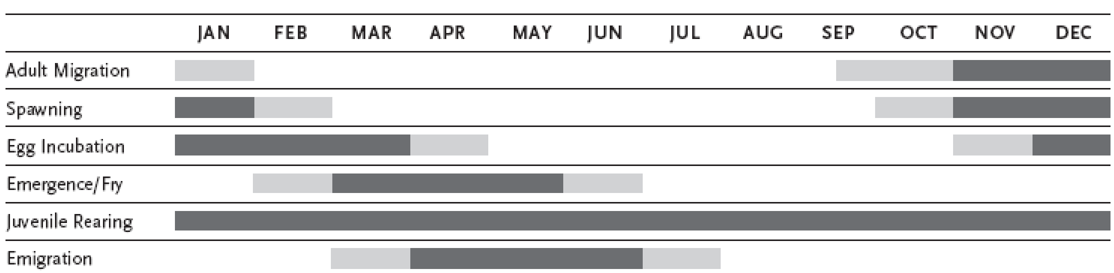
[4] A brood year is identified by the year in which spawning begins. For example, offspring of coho that migrated up the Klamath River to spawn in the Shasta River in the later part of 2001 or early part of 2002 are identified as "Brood Year 2001."

[5] The Endangered Species Act requires the federal government to designate "critical habitat" for any species it lists under the Act. "Critical habitat" is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

spawning sites near the head of a riffle, just below a pool, where the water changes from a smooth to a turbulent flow. Spawning sites are often located in areas with overhanging vegetation. Medium to small-sized gravel is essential for successful coho salmon spawning. Females dig nests, called “redds,” in the gravel and deposit approximately one hundred to several thousand eggs in each (CDFG, 2004a). After fertilization, the eggs are buried by the female digging another redd just upstream, which carries streambed materials a short distance downstream to the previous redd. The flow characteristics of the redd location usually ensure good aeration of eggs and embryos, and the flushing of waste products.

In California, coho salmon eggs generally incubate in the gravels from November through April. After hatching, the hatchlings, called “alevins,” remain within the gravel bed for two to 10 weeks before they emerge as fry into the actively flowing channel between February and June. The fry seek out shallow, low velocity water, usually moving to the stream margins, where they form schools. As the fish feed heavily and grow, the schools generally break up and individual fish set up territories. At this stage, the juvenile fish are called “parr.” As the parr continue to grow and expand their territories, they move progressively into deeper water until July and August, when they inhabit the deepest pools. Rearing areas used by juvenile coho salmon include low-gradient coastal streams, lakes, sloughs, side channels, estuaries, low-gradient tributaries to large rivers, beaver ponds, and large slackwaters. The most productive juvenile habitats are found in smaller streams with low-gradient alluvial channels containing abundant pools formed by LWD such as fallen trees.

Juvenile coho salmon typically rear in freshwater for an entire year before ocean entry (see **Figure 3.3-2**). This necessitates survival of juvenile coho salmon in streams through the winter months. Inland winter streamflows are characterized by periods of cold low flows interspersed with freshets and possibly floods. Juvenile coho salmon require areas of velocity refuge during periods of high flows. Potential habitats offering velocity refuge during winter include off-channel habitats and beaver ponds.



NOTE: Dark shading indicates months of peak activity for a particular life stage; the lighter shading indicates months of lesser activity.

SOURCE: CDFG, 2004a

Figure 3.3-2
Seasonal Presence of Coho Salmon Life Cycle Stages
in California Coastal Watersheds

After spending one year in fresh water, the majority of the juvenile coho salmon hatched during the previous spring begin migrating downstream to the ocean in late March/early April through June. Juvenile salmonids migrating toward the ocean are called "smolts." Upon entry into the ocean, the immature salmon remain in inshore waters, congregating in schools as they move north along the continental shelf. After two years of growing and sexually maturing in the ocean, coho salmon return to their natal streams as three-year-olds to begin the life cycle again.

This three-year cycle is fairly rigid among coho salmon as they rarely spend less than two years in the ocean.[6] Since wild female coho salmon are typically three years old when spawning, there are three distinct and separate maternal brood year lineages for each stream. For example, almost all coho salmon produced in 1994 were progeny of females produced three years earlier in 1991, which in turn were progeny of females produced three years earlier in 1988, and so on. The three maternal brood year lineages are:

Brood Year Lineage I:	….1994….1997.…2000….2003….2006
Brood Year Lineage II:	….1995….1998.…2001….2004….2007
Brood Year Lineage III:	….1996….1999.…2002….2005….2008

This life cycle has been cited as a major reason for coho salmon's greater vulnerability to catastrophic events compared to other salmonids (CDFG, 1998). Should a major event, such as El Niño floods or anthropogenic disturbance severely deplete coho salmon stocks during one year, the effects will be noticed three years later when few or no surviving female coho salmon return to continue the brood year lineage.

Habitat Requirements

Suitable aquatic habitat conditions are essential for migrating, spawning, and rearing coho salmon. Important components of productive freshwater habitat for coho salmon include a healthy riparian corridor, presence of LWD in the channel, appropriate substrate type and size, a relatively unimpaired hydrologic regime, low summer water temperatures, and relatively high dissolved oxygen concentrations. The importance of these habitat parameters is further described below, based on a summary provided in CDFG (2004a).

Riparian vegetation provides many essential benefits to stream conditions and habitat. It serves as a buffer from sediment and pollution, influences the geomorphology and streamflow, and provides streambank stability. The riparian buffer is vital to moderating water temperatures that influence spawning and rearing by providing the canopy, which protects the water from direct solar heating, and the buffer, which provides a cooler microclimate and lower ambient temperatures near the stream. The riparian canopy also serves as cover from predators, supplies both insect prey and organic nutrients to streams, and is a source for LWD.

LWD within the stream channel is an essential component of coho salmon habitat with several ecological functions. It stabilizes substrate, provides cover from predators and shelter from high

6 Some coho return to spawn after spending only one year in the ocean. These fish are referred to as grilse or jacks.

water velocities, aids in pool and spawning bed establishment and maintenance, and provides habitat for aquatic invertebrate prey.

The channel substrate type and size, and the quantity and distribution of sediment, have essential direct and indirect functions at several life stages of coho salmon. Adults require gravel of appropriate size and shape for spawning (building redds and laying/fertilizing the eggs). Eggs develop and hatch within the substrate, and alevins remain there for some time for protection and shelter. An excess of fine sediment such as sandy and/or silty materials is a significant threat to eggs and fry because it can reduce the interstitial flow necessary to regulate water temperature and dissolved oxygen, remove excreted waste, and provide food for fry. Fine sediments may also envelop and suffocate eggs and fry, and reduce available fry habitat. The substrate also functions as habitat for rearing juveniles by providing shelter from faster flowing water and protection from predators. Furthermore, some invertebrate prey inhabit the benthic environment of the stream substrate.

The characteristics of the water and geomorphology of the stream channel are fundamentally essential to all coho salmon life stages. Important characteristics include water velocity, flow volume, water depths, and the seasonal changes and dynamics of each of these (e.g., summer flow, peak flow, and winter freshets). Appropriate water temperature regimes, in particular, are essential throughout the freshwater phases of the coho salmon life cycle. Water temperature affects the rate and success of egg development; fry maturation; juvenile growth, distribution, and survival; smoltification; initiation of adult migration; and survival and success of spawning adults. Water temperature is influenced by many factors including streamflow, riparian vegetation, channel morphology, hydrology, soil-geomorphology interaction, climate, and impacts of human activities. The heat energy contained within the water and the ecological paths through which heat enters and leaves the water are dynamic and complex.

As a general guideline, the appropriate water temperature range for coho salmon is approximately 3-20°C (37-68°F) (Hardy and Addley, 2001), although preferred rearing temperatures are 12-14°C (54-57°F) (Bjornn and Reiser, 1991). Temperatures above 16.5°C (61.7°F) have been documented to result in a 10 percent weight decrease in juvenile coho salmon (Sullivan et al., 2000) and upper lethal temperatures have been reported as 26°C (79°F) (Bjornn and Reiser, 1991; Sullivan et al., 2000). However, water temperature requirements must be considered in relation to the unique physiological phenomena associated with each life stage. Additionally, environmental conditions in specific watersheds may affect the normal range and extreme end-points for any of these temperature conditions for coho salmon within these watersheds. The water temperature requirements for coho salmon are dependent on their metabolism and health, and on available food. These factors need to be considered together when trying to understand the habitat needs of coho salmon in a particular watershed or river system.

An adequate level of dissolved oxygen is necessary for each life stage of coho salmon and is affected by water temperature, instream primary productivity, and streamflow. Fine sediment concentrations in gravel beds can also affect dissolved oxygen levels, impacting eggs and fry. Dissolved oxygen levels in streams and rivers are typically lowest during the summer and early fall, when water temperatures are higher and streamflows lower than during the rest of the year. Dissolved oxygen concentrations of 8 mg/L or higher are typically considered ideal for rearing salmonids including coho salmon. Rearing juveniles may be able to survive when concentrations are relatively low (e.g., less than 5 mg/L), but growth, metabolism, and swimming performance are adversely affected (Bjornn and Reiser, 1991).

Population Trends

Historically, the Shasta River was one of the most productive salmon streams in California (NRC, 2004). However, even as early as 1931, Snyder (1931) referred to the Shasta River as a "stream *once* famous for its trout and salmon" (emphasis added). By the 1960s, CDFG estimated the annual coho salmon run of the Shasta River at 1,000 fish (NRC, 2004).

CDFG has operated the Shasta River Fish Counting Facility (SRFCF) at the mouth of the Shasta River since 1930.[7] The primary purpose of the weir has been to facilitate development of fall Chinook escapement estimates, and with a few exceptions, the weir was historically removed each year prior to the height of the coho salmon migration and spawning period. However, since 2001, the SRFCF has been operated beyond the Chinook salmon migration period in an effort to better document coho salmon returns in the Shasta River. High flows, common during the coho salmon migration period, have nevertheless compromised CDFG's ability to gather consistent data on annual coho salmon run sizes (Hampton, 2006). Because of the inconsistencies in sampling duration over the years, direct comparisons of the annual coho salmon counts are not possible, and the numbers presented in **Table 3.3-1** should not be construed as total run sizes.

The currently known and suspected spatial distribution of coho salmon in the Shasta River watershed is depicted in **Figure 3.3-3**. Formal coho salmon spawning ground surveys of redds and carcasses have not been conducted in the Shasta River, but in 2004, 2006, and 2007, CDFG trapped adult coho salmon at the SRFCF and implanted them with radio tags to investigate migration behavior and distribution (Littleton and Pisano, 2006; 2007; Littleton et al., 2008). The results of these studies indicate that adult coho salmon currently migrate primarily to two distinct areas of the Shasta River watershed to spawn: the canyon reach (lower seven miles) of the mainstem river and the upper region of the Shasta River (beyond RM 34) known as the Big Springs complex, including the mainstem Shasta River, Big Springs Creek, and Parks Creek. **Figure 3.3-4** and **Figure 3.3-5** depict the upstream extent of migration of individual tagged adults in 2007 for the canyon reach and the Big Springs complex, respectively.

CDFG has also been conducting annual rotary screw trap surveys on the Shasta River since 2001 to monitor outmigrant salmonid juveniles, including coho salmon. Coho salmon smolt population estimates were derived from the trapping results since 2003. The results of the surveys are summarized in **Table 3.3-2**. In addition to coho salmon smolts (age 1+ fish) migrating out of the watershed, CDFG has also observed distinct emigrations of age 0+ juveniles from the watershed (Chesney and Yokel, 2003; Chesney et al., 2007). The reasons for the observed emigration of

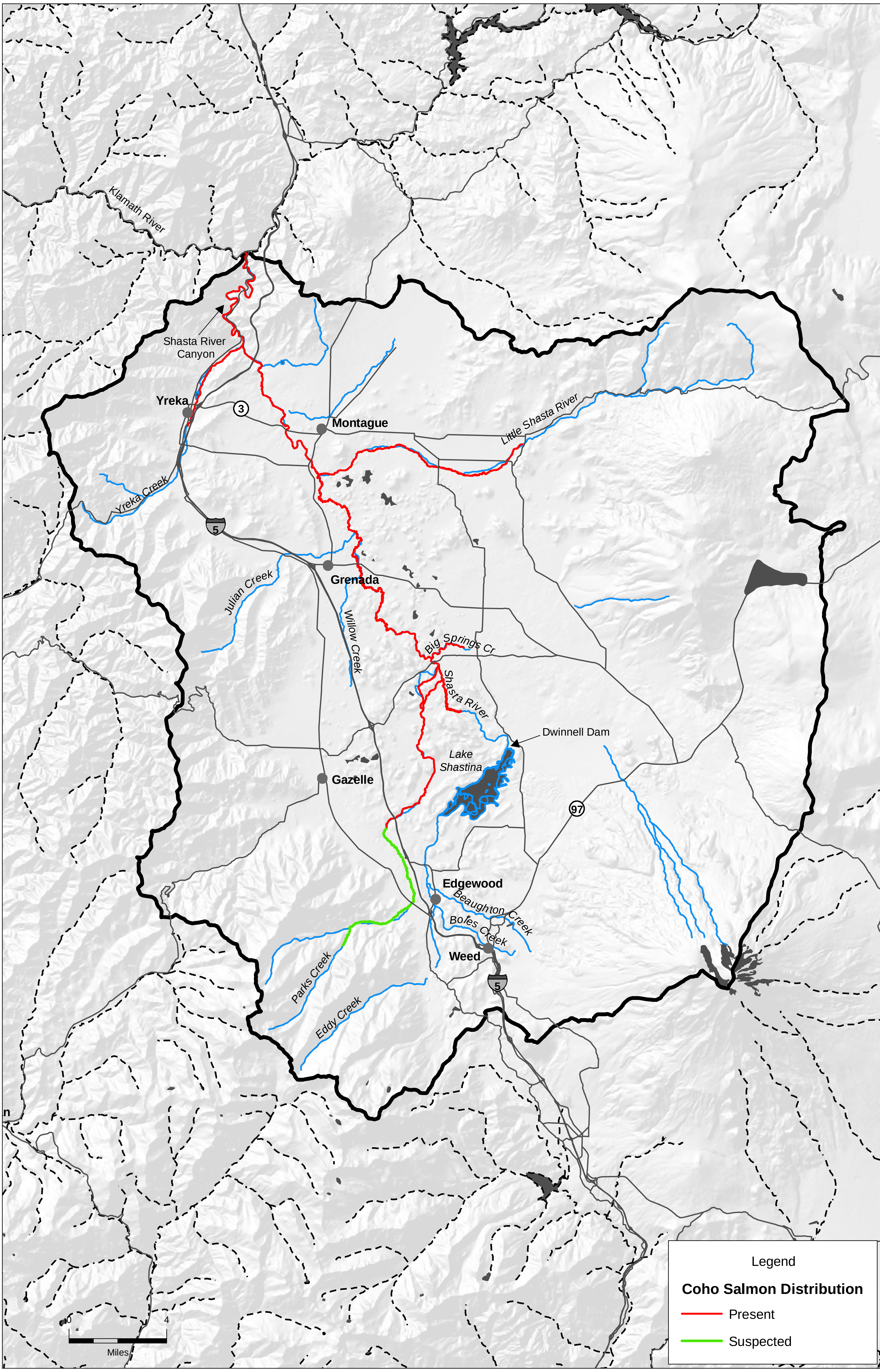
7 Between 1938 and 1957, the SRFCF was operated approximately 6.5 miles upstream of the mouth of the Shasta River.

TABLE 3.3-1
YEAR, DATES OF OPERATION, AND COUNTS OF EARLY RETURNING COHO SALMON AT THE SHASTA RIVER FISH COUNTING FACILITY

Year	Last Day of Operation	Coho Salmon Counts
1979	Unknown	355
1981	1/6/82	418
1982	2/28/83	263
1983	1/19/84	36
1984	11/19/84	69
1985	Early December	3
1986	11/3/86	0
1987	10/12/87	0
1988	11/2/88	3
1989	10/21/89	6
1990	10/28/90	2
1991	11/11/91	9
1992	11/11/92	3
1993	11/12/93	6
1994	11/6/94	17
1995	11/11/95	12
1996	11/14/96	1
1997	10/28/97	0
1998	11/4/98	0
1999	11/10/99	27
2000	11/7/00	1
2001	12/14/01	291
2002	12/17/02	86
2003	12/28/03	187
2004	12/8/004	373
2005	12/12/05	69
2006	12/13/06	47
2007	12/31/07	255 (preliminary)

SOURCE: Hampton, 2006; Hampton, 2007; Walsh and Hampton, 2007.

age 0+ coho salmon from the Shasta River are not yet fully understood, but one possible explanation is that while most juvenile coho salmon typically rear in freshwater for an entire year before ocean entry, recent data from the Shasta River indicate that due to the high productivity in a portion of the watershed, a percentage of the age 0+ juvenile coho salmon are able to reach a size that allows them to emigrate as smolts in the spring and early summer of their first year (**Table 3.3-3**). CDFG has observed age 0+ coho salmon smolts in the catch at the rotary trap located near the mouth of the Shasta River since 2003. Analysis of scale and otolith samples collected in 2003 through 2006 determined that coho salmon smolts or "silvery parr" emigrating from the Shasta River between May 21st through July 15th, with a fork length greater than 90 mm and less than 120mm, were almost exclusively age 0+ smolts (Chesney, 2008a). On April 8, 2008, Carson Jeffres observed coho salmon rearing in Big Springs Creek which were significantly larger than coho salmon in the rest of the watershed (Jeffres, 2008) and generally fell



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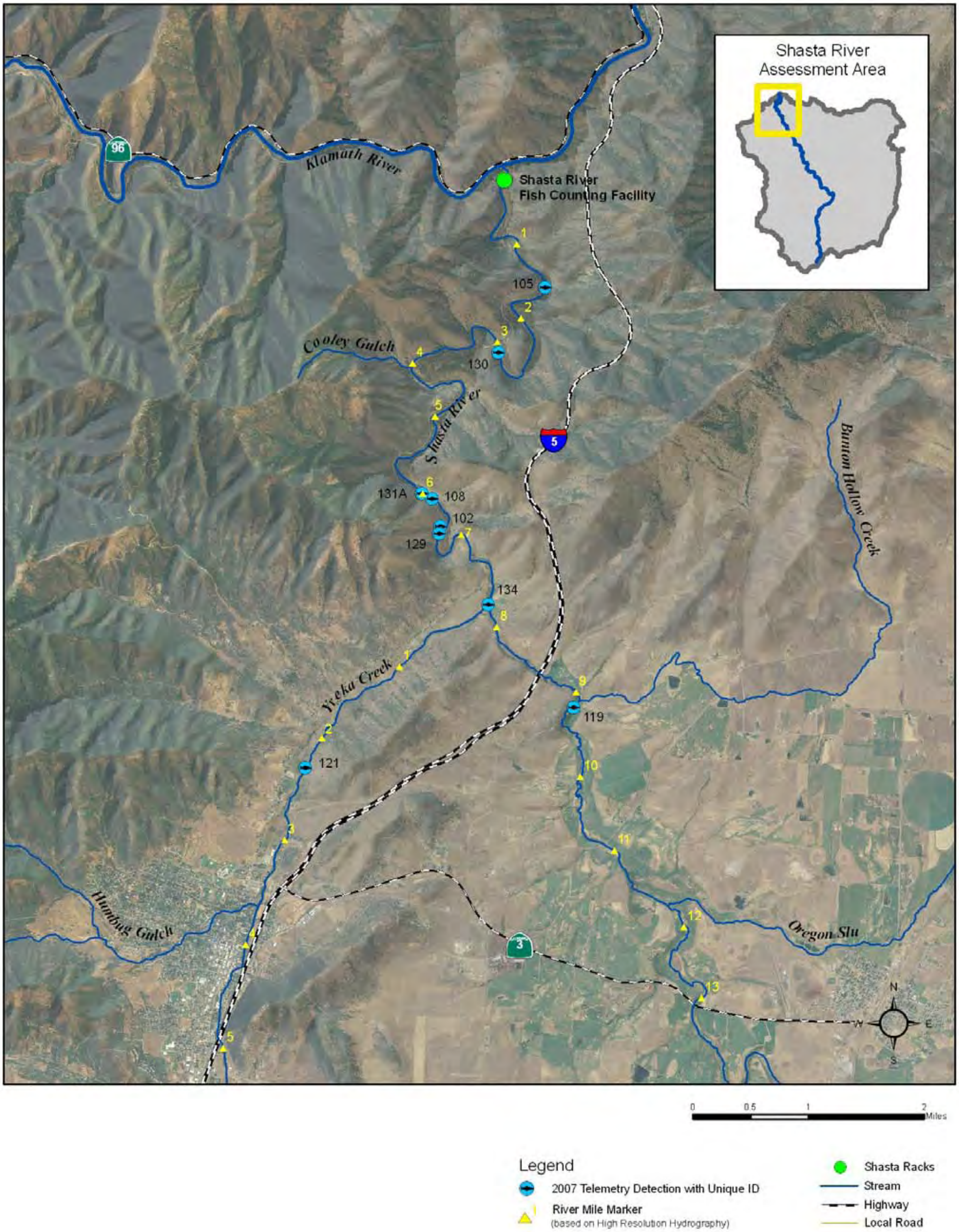
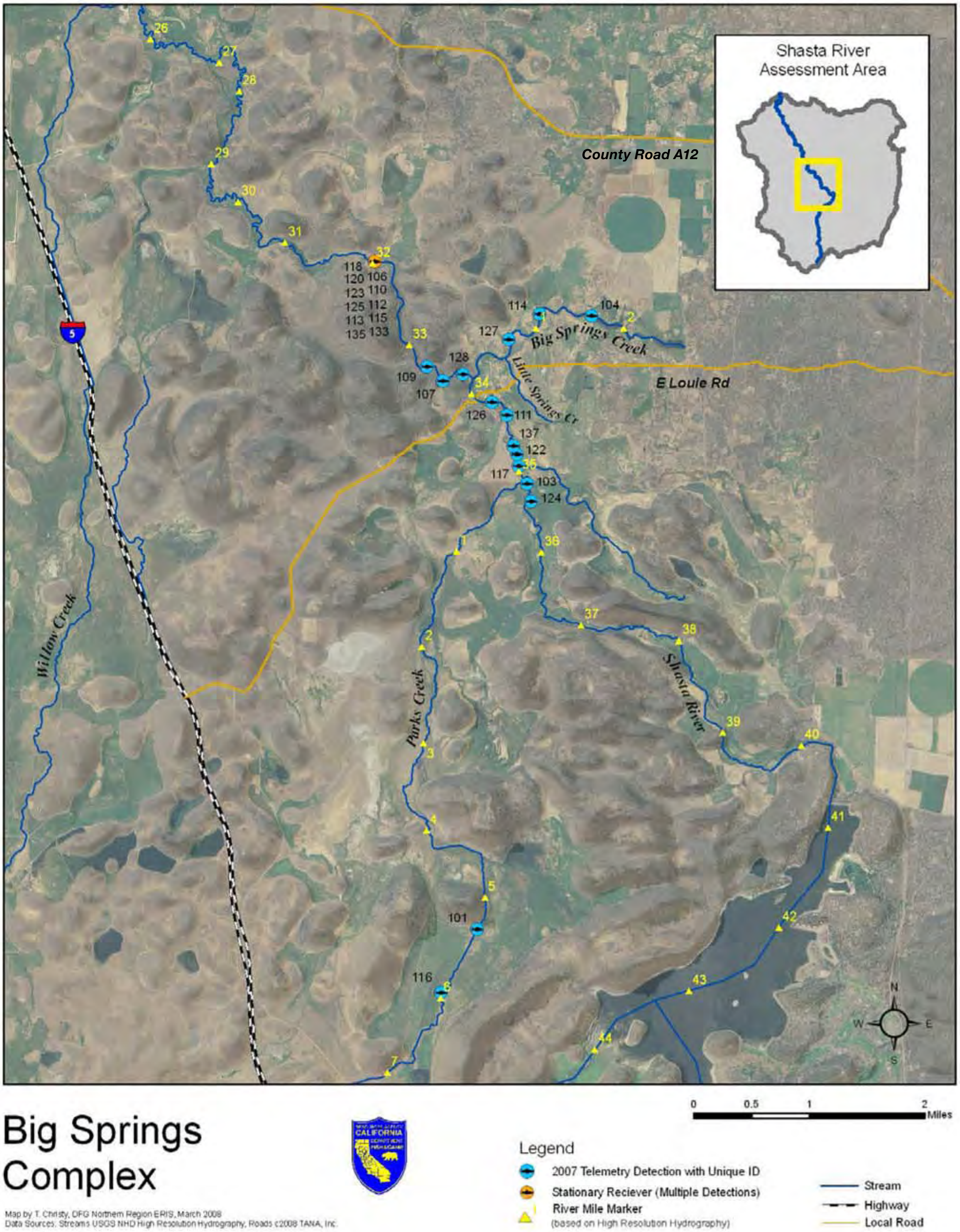
SOURCE: ESA, 2007

Figure 3.3-3
Coho Salmon Distribution within the Shasta River Watershed



SOURCE: Map by T. Christy. DFG Northern Region ERIS, March 2008
Data Sources: Streams USGS N-ID High Resolution Hydrography, Roads c2008 TANA, Inc.

Figure 3.3-4
Shasta River Canyon



SOURCE: Map by T. Christy. DFG Northern Region ERIS, March 2008
Data Sources: Streams USGS N-ID High Resolution Hydrography, Roads c2008 TANA, Inc.

Figure 3.3-5
Big Springs Complex

TABLE 3.3-2
YEARLY SHASTA RIVER WATERSHED JUVENILE COHO PRODUCTION ESTIMATES BASED ON OUTMIGRANT TRAPPING SURVEYS

	2003	2004	2005	2006	2007
Age 0+ coho	292[a]	1,135	15,581	870	NA
Age 1+ coho	11,052	1,799	2,054	10,833	1,178 [b]

a NOTE: Due to low number of age 0+ recaptures during the 2003 season, a production estimate was not possible and the number presented is a total count of fish captured.
b NOTE: Due to anticipated low numbers of age 1+ coho salmon in 2007, mark/recapture methods to estimate trap efficiency were not used in 2007; instead, efficiency was estimated based on a correlation between trap efficiency data for age 2+ steelhead in 2007 and age 1+ coho salmon in 2004 and 2005.

SOURCE: Chesney et al., 2007; Chesney, 2007; Chesney, 2008a.

TABLE 3.3-3
RELATIVE CONTRIBUTION OF AGE 0+ COHO SALMON SMOLTS TO THE OVERALL COHO SALMON SMOLT COUNTS IN THE SHASTA RIVER WATERSHED BASED ON OUTMIGRANT TRAPPING SURVEYS

	2003	2004	2005	2006
Age 0+ coho salmon smolts	2	622	1,791	112
Age 1+ coho salmon smolts	11,052	1,799	2,054	10,833
Total coho salmon smolts	11,054	2,427	3,845	10,946
Percentage of 0+ coho salmon smolts	0.02%	25.71%	46.58%	1.02%

SOURCE: Chesney, 2008a.

within the size range of the age 0+ smolts observed at CDFG's rotary trap. During instream surveys on May 6, 2008, CDFG staff observed coho salmon of a similar size rearing at a location upstream of Big Springs Creek on the Shasta River mainstream between approximately RM 36.1 and RM 37.1. During subsequent surveys performed in this section of the stream the first two weeks of June, 2008, CDFG staff counted approximately 450+ juvenile coho salmon which appeared to be within this size range.

Although the data on adult coho salmon returns at the SRFCF (Table 3.3-1) are inconsistent due to varying sampling periods, a comparison of the data collected since 2001 with the smolt outmigration data presented in Table 3.3-2 suggests that only one strong brood year lineage (2001…2004…2007)[8] remains within the Shasta River watershed.

8 Note that age 0+ fish are of the previous year's brood lineage and age 1+ fish are offspring of the brood lineage from two years ago. Thus, adults observed at SRFCF in 2004, age 0+ fish observed at the rotary trap in 2005, and age 1+ fish observed at the rotary trap in 2006, are all progeny of the 2001…2004 brood lineage.

Using the counts of returning adult coho salmon from the SRFCF since 2001 (Table 3.3-1) and the annual estimates for age 1+ coho salmon since 2003 (Table 3.3-2), CDFG developed a relationship between the number of returning adults and the subsequent number of smolts produced from the same brood year. Based on the estimated numbers of smolts produced per adult returning in 2001 through 2004, CDFG projected that an average of 24.7 smolts will have been produced for each adult that returned in 2005 and 2006 (Chesney et al., 2007). The past and projected coho salmon smolt productions in the Shasta River watershed are summarized in **Table 3.3-4**.

TABLE 3.3-4
RELATIONSHIP BETWEEN THE NUMBER OF RETURNING COHO SALMON ADULTS AND THE NUMBER OF SMOLTS PRODUCED

Brood Year	# of adults	# of smolts produced	Year	# of smolts per adult
2001	291	11,052	2003	38.0
2002	86	1,799	2004	20.9
2003	187	2,054	2005	11.0
2004	373	10,833	2006	29.0
2005	69	1,178	2007	17.0
2006	47	1,090	2008	23.2
2007	255	5,516	2009	23.2

NOTE: Shaded cells represent projections. Projected numbers of smolts per adult for brood years 2006 and 2007 are based on average of numbers (23.2) estimated for 2001 through 2005.

SOURCE: Chesney et al., 2007; Chesney, 2008a.

Based on the data presented above, CDFG has also projected the number of adult coho salmon expected to return to the Shasta River in 2008, 2009, and 2010. Based on the observed number of outmigrating smolts in 2003 through 2007, and the subsequent return of adults observed in 2004 through 2007, CDFG estimated that an average of 2.96 percent of smolts return as adults (Chesney, 2008a). Applying this ratio to the known and projected numbers of smolts for 2007, 2008, and 2009, CDFG estimated the numbers of returning adults over the following years at 35 (2008), 32 (2009), and 175 (2010), respectively (Chesney, 2008a). The results of these projections are presented in **Table 3.3-5**.

It should be noted that the above projections are based on three data points for the 2001…2004…2007 brood year lineage and only two data points for the other two lineages. Greater confidence in predicting future returns will require additional monitoring and consideration of confidence intervals for such projections. Nevertheless, the data reinforce the indication that only one strong brood year lineage remains in the Shasta Valley and suggests that coho salmon of all three brood years appear to be on a downward trend. Across the range of coho salmon along the California coast, an average decline of 73 percent in returning adults occurred in 2007 compared to the same cohort in 2004 (McFarlane et al., 2008). The observed decline for the Shasta River was 32 percent (McFarlane et al., 2008).

TABLE 3.3-5
OBSERVED AND PROJECTED SHASTA RIVER WATERSHED COHO SALMON PRODUCTION

Brood Year	# of Adults	Emigration Year	# of smolts produced	% Return	# of Adults Returning	Return (Brood) Year
2001	291	2003	11,052	3.37%	373	2004
2002	86	2004	1,799	3.84%	69	2005
2003	187	2005	2,054	2.29%	47	2006
2004	373	2006	10,833	2.35%	255	2007
2005	69	2007	1,178	2.96%	35	2008
2006	47	2008	1,090	2.96%	37	2009
2007	255	2009	5,916	2.96%	175	2010

NOTE: Shaded cells represent projections. Projected numbers of returning adults for 2008 through 2010 are based on average rate of return (2.96 percent) for 2004 through 2007.

SOURCE: Chesney et al., 2007; Chesney, 2008a.

Chinook Salmon

Status

Chinook salmon in the Shasta River watershed are part of the federally-designated Upper Klamath and Trinity Rivers Chinook ESU, which includes all populations upstream of the confluence of these two rivers. NMFS determined on March 9, 1998 that this ESU did not warrant listing under ESA. Spring-run Chinook salmon within this ESU are a CDFG species of special concern.

Life Cycle

The life history patterns of Chinook salmon vary among runs. The Klamath River Basin, including the Shasta River, currently supports fall-run and historically supported spring-run Chinook salmon. A third run, the late fall-run, may also have historically existed in the basin, but it is either poorly documented or extinct (Moyle, 2002). The spring-run differs from the fall-run in that the adults enter the river before they are ready to spawn and reside in deep pools for two to four months before they spawn, whereas fall-run adults spawn soon after reaching their spawning destination (Moyle, 2002). In addition, spring-run juveniles may remain in the streams for a year or longer before their seaward migration, whereas fall-run juveniles are generally less than one year old before they migrate to sea.

Adult fall-run Chinook salmon entry into the Klamath River Basin typically peaks in September and continues through late October, with adults arriving at their spawning grounds approximately two to four weeks after freshwater entry (NRC, 2004). As such, adult Chinook salmon typically arrive in the Shasta River watershed prior to the peak of coho salmon spawning migration. Chinook salmon tend to spawn in lower gradient reaches than coho salmon, primarily in rivers and larger streams. Within the Shasta River watershed, Chinook are known to spawn in the mainstem Shasta River (Canyon reach and vicinity of Big Springs Creek), Parks Creek, and Big Springs Creek (CDFG, 1997; Chesney et al., 2007). Spawning also occurs in two other tributaries, Yreka Creek and Little Shasta River, during years when a hydrologic connection between the tributaries and the mainstem exist at the time of the Chinook spawning migration. The majority of juvenile fall-run Chinook salmon spend only a few months rearing in freshwater before outmigrating in the spring and early summer. Peak smolt outmigration from the Shasta River typically occurs in March and April (Chesney et al., 2007)

Spring-run Chinook salmon enter rivers as immature fish in spring and early summer. They migrate to their upstream spawning sites where they hold for several months in deep, cool pools prior to spawning in early fall. Juvenile spring-run Chinook salmon rear in freshwater for three to fifteen months with outmigration peaking in winter (January – February) and again in spring (April) (Moyle, 2002).

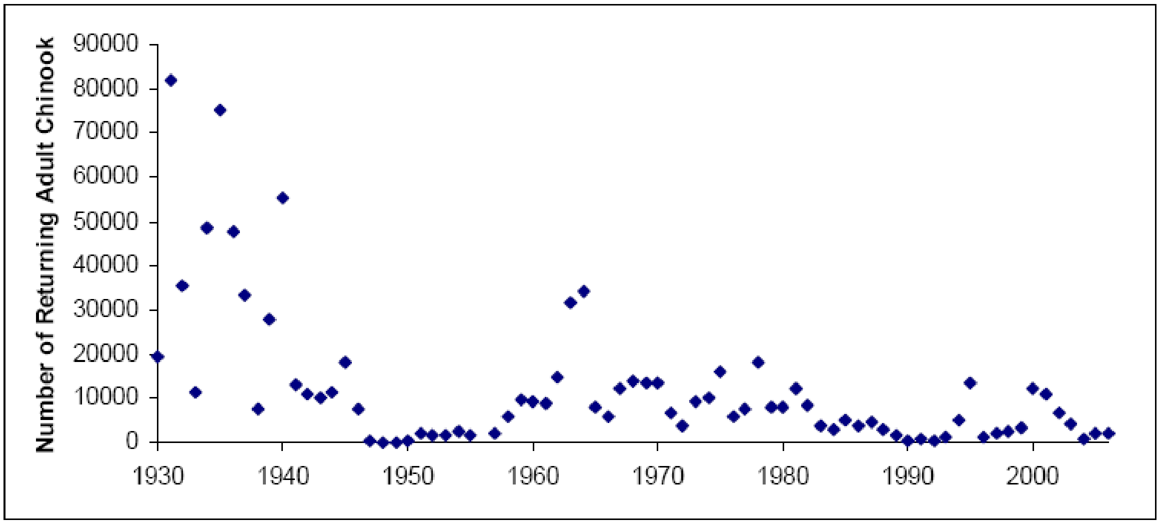
Habitat Requirements

Although the life history patterns of Chinook salmon differ from that of coho salmon, the overall habitat requirements of the two species are fairly similar. Like coho salmon, Chinook salmon require adequate flows, temperatures, water depths and velocities, appropriate spawning and rearing substrates, and availability of instream cover and food. The importance of these habitat parameters are described above for coho salmon.

Adult holding areas, consisting of deep pools with cool water temperatures, are of particular importance to spring-run Chinook which must reside in the freshwater streams and rivers throughout the summer. Adult fall-run Chinook salmon, on the other hand, are particularly dependent on adequate streamflows in the fall, prior to the onset of significant precipitation, to enable successful migration to their spawning sites. Most juvenile Chinook salmon leave their freshwater habitat in the spring and are therefore not as susceptible to the high water temperatures and low streamflows that are common during summer and early fall. The optimal rearing temperature range for juvenile Chinook salmon is approximately 14 to 19ºC (57-66ºF) (Hardey and Addley, 2001), which is somewhat higher than that of coho salmon. The upper lethal temperature for Chinook salmon, however, is similar to that of coho salmon which has been reported as 26°C (79°F) (Bjornn and Reiser, 1991).

Population Trends

Historically, the Shasta River was one of the most productive salmon streams in California, with runs of Chinook salmon over 80,000 returning adults in the 1930s (NRC, 2004). Since the 1940s, Chinook salmon numbers have decreased dramatically (**Figure 3.3-6**). Between 2001 and 2006, Chinook returns averaged 4,566 adults per year with a high of 11,093 and a low of 978 (Jeffres et al., 2008). Construction of Dwinnell Dam in 1928 precluded salmon from accessing the upper watershed, effectively eliminating an estimated 22 percent of the total spawning habitat formerly available to salmon and steelhead (Wales, 1951), and altered habitat conditions downstream. Over time the combination of lower summer flows and less frequent and smaller magnitude peak winter flows resulted in sedimentation of fine material within the gravels and encroachment of riparian vegetation. This reduction in stream size resulted in a considerable loss of spawning habitat in the reach from Dwinnell Dam to Big Springs Creek. It is possible that the gradual loss of spawning habitat below Dwinnell Dam allowed Chinook salmon populations to be maintained



SOURCE: Jeffres et al., 2008

Figure 3.3-6
Fall-run Chinook Salmon Returns in the Shasta River, 1930 – 2006

at relatively high numbers for several years after dam construction, but ultimately the combined loss of both upstream and downstream habitat may have led to numbers more consistent with current conditions (Jeffres et al., 2008). Recent spawning habitat surveys have shown that from Dwinnell Dam to the mouth, the quality of spawning gravels is poor (Ricker, 1997).

Spring-run Chinook salmon, once the most abundant Chinook run in the Klamath River basin (Hardy and Addley, 2001), were reportedly present in the Shasta River until at least 1850 (West, 1991), and a remnant population of this run is generally believed to be confined to the Salmon River watershed (Chesney, 2007). However, in October 2006, CDFG personnel operating a screw trap on the mainstem Shasta River noted that some juvenile male Chinook salmon caught in the trap were sexually mature (Jeffres et al., 2008). Mature male juveniles are very rare in nature and are most often found in spring-run Chinook salmon that hatch earlier than fall-run fish, and thus are able to grow more rapidly and mature at an earlier age (Jeffres et al., 2008). While the potential exists for these early maturing juveniles to be offspring of a vestigial run of spring Chinook salmon in the Shasta River, they may also be the product of early spawning fall-run Chinook salmon utilizing spawning gravels in the vicinity of Big Springs Creek. As this area is influenced by warmer spring flows naturally rich in nutrients, the incubation period is likely reduced and the resultant fry emerge earlier to experience a longer growing period in a highly productive environment. This could also lead to early sexual maturation and precocious behavior. Additional evaluation is needed.

Steelhead

Status

Steelhead within the Shasta River basin are part of the federally-designated Klamath Mountains Province Distinct Population Segment (DPS). Listing of this DPS under ESA was determined not to be warranted by NMFS on April 4, 2001. Summer-run steelhead within this DPS are a CDFG species of special concern.

Life Cycle

Steelhead exhibit one of the most complex life histories of any salmonid species. The resident rainbow trout form spends its entire life in freshwater environments, while the anadromous steelhead form migrates between its natal streams and the ocean. Furthermore, two reproductive forms of steelhead are recognized, the summer-run (stream-maturing) and winter-run (ocean-maturing), which describes the level of sexual development following return to the freshwater environment. Some researchers further divide the winter steelhead into early (fall-run) and late (winter-run) (e.g., Hardy and Addley, 2001), but the two forms have similar life histories (NRC, 2004) and are treated together here as winter-run steelhead. In addition, the Klamath River Basin is distinctive in that it is one of the few basins producing ‘‘half-pounder’’ steelhead. This life history type refers to immature steelhead that return to fresh water after only two to four months in the ocean, generally over-winter in fresh water, then outmigrate again the following spring (NMFS, 2001b).

Unlike salmon, steelhead are iteroparous, meaning they can spawn more than once before they die. In California, females commonly spawn twice before they die. Adult winter-run steelhead typically enter the Klamath River from late August to February before spawning, which extends from January through April, peaking in February and March (NRC, 2004). Summer-run steelhead enter freshwater as immature fish from May to July, migrate upstream to the cool waters of larger tributaries, and hold in deep pools roughly until December, when they spawn (NRC, 2004). Juvenile steelhead rear in freshwater for one to three years (mostly two) before migrating downstream toward the ocean in spring, primarily during the months of March through May. They then typically reside in marine waters one to three years prior to returning to their natal stream to spawn as three- or four-year olds.

Habitat Requirements

As discussed above, the overall habitat requirements of the various salmonid species are fairly similar. Like coho salmon, steelhead require adequate flows, temperatures, water depths and velocities, appropriate spawning and rearing substrates, and availability of instream cover and food. The importance of these habitat parameters are described above for coho salmon.

Notable differences in habitat preferences include the fact that while juvenile coho salmon prefer pools with low average velocities and are not as common in riffles with high current velocities, juvenile steelhead tend to occupy riffles as well as deep pools with relatively high velocities along the center of the channel (Bisson et al., 1988). Similar to spring-run Chinook salmon, adult holding areas are of particular importance to summer-run steelhead who must reside in the freshwater streams and rivers throughout the summer. The thermal tolerance of steelhead is generally higher than that of most other salmonids. Preferred temperatures in the field are usually 15 to 18°C (59-64°F), but juveniles regularly persist in water where daytime temperatures reach 26 to 27°C (79-81°F) (Moyle, 2002). Long-term exposure to temperatures continuously above 24°C, however, is usually lethal (NRC, 2004; Moyle, 2002).

Population Trends

Population trends of steelhead within the Program Area have not been monitored as closely as those of coho and Chinook salmon. Within the Klamath Basin, historical numbers of winter steelhead are not known, but total run sizes in the 1960s were estimated at about 170,000 for the Klamath River and 50,000 for the Trinity River (NRC, 2004). In the 1970s, Klamath River runs were estimated to average around 129,000 and by the 1980s, they had dropped to around 100,000 (NRC, 2004). In 2001, NMFS estimated the natural escapement for the entire Klamath Mountains Province DPS at 100,000 to 130,000 adults per year, with the California portion of the DPS contributing approximately 30,000 to 50,000 adults (NMFS, 2001b).

Summer-run steelhead once were widely distributed in the Klamath Basin and were present in most headwaters of the larger tributaries (NRC, 2004). In the 1990s, estimated numbers were 1,000 to 1,500 adults across eight populations – less than 10 percent of their former abundance (Moyle, 2002). Numbers presumably are still declining because of loss of habitat, poaching in summer, and reduced access to upstream areas during migration periods as a result of diversions (NRC, 2004). Summer-run steelhead were observed in the mainstem Shasta River as recently as June 2007 (Jeffres et al., 2008).

Lampreys

Status

Three lamprey species have been observed in the Shasta River watershed: river lamprey; Klamath River lamprey; and Pacific lamprey (Chesney et al., 2007). The river and Klamath River lampreys are CDFG fish species of special concern. The U.S. Fish and Wildlife Service (USFWS) determined in 2004 that a formal listing of the Pacific lamprey under ESA was not warranted (USFWS, 2004). However, there is reasonable likelihood that the Pacific lamprey may become listed in the foreseeable future and they are also considered a tribal trust species with a high priority for recovery to fishable populations (NRC, 2004). Therefore, Pacific lamprey is treated as a CDFG fish species of special concern for the purposes of this Draft EIR.

Life History

Lampreys are anadromous. Like salmon and steelhead, they hatch in freshwater streams, migrate out to the ocean, and return to fresh water as mature adults to spawn. Landlocked forms that do not migrate to the ocean are also known, including from the Upper Klamath Basin (Moyle, 2002). The life history of the Klamath River lamprey has not been documented and the biology of river lampreys has only been studied in British Columbia where the timing of life history events may or may not be the same as in California (Moyle, 2002). Thus, the following description focuses largely on Pacific lampreys.

Most adult Pacific lampreys enter freshwater from January through March to spawn from March to June, although movement has also been observed in most other months (Moyle, 2002). Most spawning appears to take place in the mainstem or larger tributaries. Like salmon, lampreys construct redds for spawning in gravel riffles. Once they emerge, larvae (ammocoetes) are carried downstream by streamflows and burrow into sand or mud substrates at the edge of the river. The larvae live in burrows for probably five to seven years, during which time they move about frequently and are commonly captured in salmon outmigrant traps (NRC, 2004). Once the ammocoetes transform into adults, they migrate to the sea. Downstream migration usually is coincidental with high flows in the spring, but movement has also been observed during summer and fall (NRC, 2004). In the ocean and estuary, they prey on salmonids and other fish for one to two years before returning to spawn.

Habitat Requirements

While in freshwater, lampreys are often found to coexist with steelhead and salmon, indicating that these species share similar habitat requirements. Juveniles require muddy bottoms, backwater areas, and low gradient areas, and it is therefore likely that rapid or frequent drops in flow deprive them of habitat and force them to move into open water, where they are vulnerable to predation (NRC, 2004). Due to the migratory behavior of the species, lamprey distribution within watersheds is also affected by barriers. They do not, however, appear to be limited by water temperatures (NRC, 2004).

Population Trends

Lampreys once were so abundant in the coastal rivers of California that they inspired the name Eel River for the third largest river in the state (NRC, 2004). Today, their numbers are low and declining (NRC, 2004; Moyle, 2002).

Other Fisheries Resources

In addition to coho salmon and the CDFG species of special concern described above, the Program Area supports other native, non-listed fish species such as western brook lamprey (*L. richardsoni*), Klamath smallscale sucker (*Catostomus rimiculus*), speckled dace (*Rhinichthys osculus*), and sculpins (*Cottus* spp.) (Chesney et al., 2007). Although the life cycles and habitat requirements of these species may differ somewhat from those of coho salmon and CDFG fish species of special concern, all native fisheries within the Shasta River have co-evolved and are similarly affected by aquatic habitat disturbances. Furthermore, populations of these species have received little attention and population trends are not available. Thus, due to their non-special status, similar preference for undisturbed aquatic habitat conditions, and lack of adequate population data, these species are not further discussed in this Draft EIR.

A number of non-native fish species are also known to be present in Lake Shastina and the Shasta River below Dwinnell Dam. The most abundant of these appear to be yellow bullhead (*Ameiurus natalis*), green sunfish (*Lepomis cyanellus*), and golden shiner (*Notemigonus crysoleucas*) (Chesney et al., 2007). To the extent the Program will adversely affect non-native fish species (e.g., direct mortality resulting from instream construction activities, potential decreases in habitat suitability resulting from decreases in water temperatures), the impacts will be less than significant because when present in streams or rivers, non-native fish species typically compete with, or prey on, native species, and therefore any reduction in non-native fish species will benefit native fish. In that regard, any reduction in the abundance or distribution of non-native fish species will only serve to further one of the primary the objectives of the Program to protect and preserve coho salmon. Thus, non-native fish species are not further discussed in this Draft EIR.

Aquatic Habitat Conditions and Utilization

This section describes the existing aquatic habitat conditions and utilization by coho salmon and CDFG fish species of special concern within the Shasta River watershed, with primary attention given to coho salmon and other salmonids. For clarity, the watershed has been divided into various sub-watershed areas based on similarities in geomorphologic and biologic conditions. Due to the large geographic scope of the Program Area, aquatic habitat conditions are described on the sub-watershed scale (e.g., adequate spawning habitat and poor rearing habitat) rather than detailed reach-by-reach accounts of existing habitat features (e.g., pool complexity and percent cover). The descriptions of the sub-watersheds are largely based on summaries provided by SVRCD (2005) and personal communications (e.g., Webb, 2007). Figure 3.3-1 depicts the Shasta River watershed, including significant tributary streams.

Shasta River Above Dwinnell Dam

The watershed of the Shasta River upstream of Dwinnell Dam is comprised of about 81,500 acres, which accounts for approximately sixteen percent of the total watershed area. Elevations in this area range from 14,162 feet at Mount Shasta to approximately 2,750 feet at the base of Dwinnell Dam. The high elevation terrain captures significant amounts of rain and snow, with precipitation ranging from 70 inches at the highest elevations to less than ten inches at the lower end of the reach. The large amount of rain and snow at high elevation creates surface flows forming Dale Creek and Eddy Creek, and also large amounts of flow from springs, especially from the flanks of Mount Shasta. Those springs form numerous tributary creeks, including Boles Creek, Beaughton Creek, and Carrick Creek, that comprise the headwaters of the Shasta River.

Dwinnell Dam, completed in 1928 and located at approximately River Mile (RM) 40.6, forms the downstream end of this reach. Although the dam was built to impound 74,000 acre feet, the Department of Water Resources (DWR) currently limits storage to 50,000 acre feet. The dam is owned and operated by the Montague Water Conservation District (MWCD), which supplies water to the City of Montague and to farmers and ranchers through a 60-mile long canal and ditch system. Lake Shastina captures the majority of runoff from the upper watershed in most years, as well as a portion of the flow of Parks Creek through the Parks Creek diversion ditch, and provides no flow release other than to meet specified irrigation demands immediately downstream. Dwinnell Dam prevents anadromous fish access to the upper watershed. It has been estimated that construction of the dam eliminated access to about 20 percent of the total spawning habitat formerly available to salmon and steelhead (CDFG, 1997) and drastic declines in Chinook salmon populations occurred subsequent to the construction of the dam (Jeffres et al., 2008).

Agricultural activity in this reach consists primarily of cow-calf operations with associated irrigated pasture and hay production. Urbanization is rapidly overtaking this portion of the Shasta Valley at the lower elevations along the Interstate 5 corridor, and around Lake Shastina. Former agricultural areas are being converted into rural residential land uses.

Water quality studies of the Shasta River watershed were conducted by the North Coast Regional Water Quality Control Board (NCRWQCB) in 2002 and 2003 (NCRWQCB, 2004). Continuous water temperature data collected in the Shasta River at Edgewood Road (RM 43)[9] from June 2002 through September 2003 indicate that weekly average temperatures are typically in excess of 20°C (68°F) during the month of July and remain above approximately 18°C (64°F) during August before dropping to more suitable temperatures for salmonids in September. Average weekly water temperatures on Boles Creek downstream of the City of Weed wastewater treatment ponds (RM 45), however, remained below 15°C (59°F) during the entire continuous monitoring period of late June 2003 through late October 2003 (NCRWQCB, 2004).

Current Habitat Function and Primary Limiting Factors

Morphologically, the Shasta River above Dwinnell Dam is characterized by wandering to meandering channels with in-channel and lateral gravel bars, moderate to steep topographic gradients, riffle-pool sequences, coarse bed materials, and confined and narrow floodplains (Jeffres et al., 2008). Most of the low elevation stream reaches throughout this sub-watershed have a large and reliable source of cold water as well as abundant supplies of spawning gravel supplied from upland areas (SVRCD, 2005). Although no detailed aquatic habitat assessments of this area have been conducted, coho salmon and the CDFG fish species of special concern would likely benefit from access to this sub-watershed.

Shasta River from Dwinnell Dam to County Road A12

The reach of the Shasta River between Dwinnell Dam and County Road A12 (officially the 99-97 Cut-Off) runs from RM 40.6 to RM 26.5. Elevations within this sub-watershed range from 7,071 feet at Herd Peak to approximately 2,500 feet at the downstream end of the reach. Tributaries to the mainstem include Parks Creek (RM 34.8), Hole in the Ground Creek (RM 34.7), and Big Springs Creek (RM 33.7). Both Parks and Big Springs Creeks are important sub-watersheds and are discussed separately below. Precipitation ranges from 30 inches annually in the highest elevations to as little as five inches near the middle of the reach. Land use consists primarily of timber harvest in the upper watershed to the east, grading into dry land grazing and then irrigated pastures and hayfields nearer the river.

The primary agricultural activities in this portion of the watershed are focused on cow-calf production involving irrigated pasture for summer grazing and irrigated hayfields for livestock feed. Additional agricultural activities include the growing of strawberry bedding plants for export. Currently, livestock exclusion fencing had been placed along approximately 11 miles of the

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9 River mile measurements for locations upstream of Lake Shastina are determined using an assumed stream length along the floor of the lake (NCRWQCB, 2004).

mainstem (Webb, 2008). Irrigation tailwater return to the river is known to occur in this reach, and is believed to be contributing to water temperature gains (SVRCD, 2005).

Demands for water in this section of the river are substantial. Even in mid-summer, flows in this area ramp up rapidly from near zero at the base of the dam, to over 100 cfs in the middle of the reach, and then decline as water is diverted for agricultural uses. The permitted season for most irrigation diversions from the mainstem Shasta River extends from April 1 through October 1 and the diversion quantity is approximately 42 cfs (Webb, 2008). Maintenance of substantial instream flows are dependent on the active efforts of the watermaster directing water downstream in periods of short supply to meet the demands of higher priority water users further downstream. An unintended consequence of the watermastering activities is that instream flows for fisheries use are maintained throughout and beyond this reach. The five active diversions in this reach of the mainstem have been screened according to CDFG/NMFS screening guidelines (Webb, 2008).

Riparian conditions within this reach vary from among the best in the entire watershed to areas significantly affected by livestock usage. Areas in the upper portion of the reach appear to be in a declining trend due to increased livestock pressure.

The entire area around Big Springs, the lower end of Parks Creek, and for several miles of the mainstem Shasta River upstream and downstream of the Big Springs Creek confluence contains numerous springs that discharge water at approximately 13 to 14.5°C (56 to 58°F) throughout the year and collectively create nearly all the instream flow of the Shasta River during the summer. Water temperatures measured during the summer of 2001 confirm that daily average temperatures in the mainstem upstream of the Parks Creek confluence frequently approach 20°C (68°F), while temperatures at the Grenada Irrigation District (GID) pumps typically remained well below 20°C (NRC, 2004). Similarly, water temperatures measured at GID during the months of June through September in 1995 through 1997 revealed mean monthly temperatures below 19.5°C (67°F), although maximum monthly water temperatures at times exceeded 24°C (75°F) (Deas, 1998). In general, temperatures in this reach increase as the downstream distance from the Big Springs area increases (Watershed Sciences, 2004). A review of aerial and infrared images collected during a July 2003 thermal infrared remote (TIR) sensing survey of the Shasta River (Watershed Sciences, 2004) reveal the opposing influences of cold spring inflows and irrigation tailwater returns on this reach of the Shasta River. While some sections of the mainstem receive cold water spring and/or groundwater accretion, and thus contain water temperatures suitable for juvenile coho salmon rearing, other sections receive tailwater return flows, primarily from flood irrigation, at temperatures that are in some cases in excess of 26°C (79°F). In addition to relatively cool summer water temperatures, the springs in this reach provide relatively warm water conditions in the winter and spring that likely promote rapid salmonid egg maturation.

Some springs are fed by seepage from Dwinnell Dam and can at times be distinguished by degraded water quality in terms of low levels of dissolved oxygen. Periodically during the irrigation season, water is released from the dam into the Shasta River to supply irrigation water for any one of three downstream users whose water rights were affected when the dam was built. The water is released from near the bottom of the reservoir, and is therefore highly variable in quality and particularly poor in mid- to late summer, and also contains non-native fish species from Lake Shastina.

Coho salmon, Chinook salmon, and steelhead use this portion of the watershed for both spawning and rearing. The area of the mainstem extending from approximately two miles below the Big Springs Creek confluence to approximately one mile upstream of the Parks Creek confluence contains suitable, albeit patchy, spawning habitat. However, stream substrates in this reach contain high levels of fine sediments which are typically associated with excessive salmon egg mortality and decreased fry emergence (Ricker, 1997). Nevertheless, approximately half of the adult coho salmon tagged during a 2004 radio telemetry tracking investigation spawned in this area of the watershed, including in the mainstem, Big Spring Creek, and Parks Creek (Littleton and Pisano, 2006) and approximately 74 percent of tagged adults spawned in this reach in 2007 (Littleton et al., 2008). Historically (post-construction of Dwinnell Dam), between one- and two-thirds of the fall Chinook run are believed to have utilized this upper area of the Shasta River watershed for spawning, and presumably it was equally suitable for coho salmon (Webb, 2007) and steelhead.

With the obvious exception of Dwinnell Dam, adult coho salmon and steelhead passage throughout this reach appears to be adequate. However, adult Chinook salmon passage and all juvenile salmonid passage may be impeded by the GID diversion dam and the Novy/Rice diversion during the irrigation season. As discussed above, inflows of spring water provide cooler summer water temperatures than the rest of the river, although temperatures do at times reach near maximum tolerance levels for salmonids in reaches influenced by water management practices. Thus, this reach, including the lower portions of Big Springs and Parks creeks, provide the best remaining, albeit suboptimal, coho salmon rearing habitat in the watershed.

Current Habitat Function and Primary Limiting Factors

Based on the presence of some cold water refugia and the observations of fisheries biologists conducting research in the watershed, this reach contains potentially high quality juvenile salmonid rearing habitat (Jeffres et al., 2008), as well as one of the primary adult coho salmon spawning grounds, in the mainstem Shasta River (e.g., Chesney, 2007). However, stream water temperatures are raised significantly by tailwater return flows from flood irrigation and possibly as a result of groundwater extractions (i.e., a decrease in cold groundwater accretion to the channel). Furthermore, spawning gravel quality is affected by fine sediment input, primarily from Parks Creek.

Shasta River from County Road A12 to Yreka Creek

This reach of the mainstem Shasta River is approximately 19.25 miles long and traverses the majority of the agricultural portions of the Shasta Valley. The river in this reach varies between an elevation of 2,500 feet at the upper end (RM 26.5) and 2,387 feet at the confluence with Yreka Creek (RM 7.75). The highest elevation in this reach is 8,158 feet at the divide between Parks Creek to the south and Willow Creek to the north. This portion of the Shasta River forms a meandering channel as it travels through the low gradient central portion of the Shasta Valley.

The drainage area of this portion of the river is located primarily to the west of the river. Significant tributaries include Willow Creek (RM 25), the Little Shasta River (RM 16), and Oregon Slough (RM 11.7). The Little Shasta River watershed is further described below. Precipitation in this reach ranges from approximately 50 inches in the higher elevations, to as little as ten inches on the valley floor.

Primary agricultural activities in this portion of the watershed are focused on cow-calf production, including the maintenance of irrigated pasture for summer grazing, irrigated hayfields for growing livestock feed for the winter, and dry upland areas usable for spring grazing and as sites for winter supplemental feeding. Additional agricultural activities include the growing of conventional and organic fruits and vegetables on a small scale, and production of alfalfa for sale to buyers outside the area.

One irrigation district, located at approximately RM 18, diverts approximately 42 cfs of surface water from this reach and approximately sixteen smaller diversions divert a combined maximum of approximately 27 cfs. Twelve diversions located in areas potentially accessible to coho salmon are currently not screened, but five were scheduled to be screened during 2007 (Webb, 2007). The above numbers do not include any diversions or screens on Willow Creek, for which reliable data is not available. However, three unscreened diversions are believed to be located on Willow Creek in reaches accessible to coho salmon (Webb, 2007).

Riparian conditions in this reach are variable, ranging from relatively good and improving conditions to areas heavily impacted by livestock. Approximately nine miles of the mainstem Shasta River are fenced on both banks, but as of March 2005, an approximately equal amount remained to be protected. Approximately one mile of riparian fencing is present on the tributary streams in this reach. Planting of trees and emergent plants has been undertaken on much of the fenced area along the mainstem, but these plantings have had very low survival rates. Stream banks in this area tend to be fine textured, highly erodible, and vertical, which makes them very susceptible to livestock hoof and grazing impacts.[10] Stream bank failures and concomitant increases in fine sediment loads are common along this reach. Furthermore, soil alkalinity over parts of the reach tends to restrict tree growth, although other areas within the reach still sustain good canopy and shade. Monitoring and hypothesis testing data that could be used to determine the causes of failure have not been collected.

This reach contains only minor cold water inputs from springs, but numerous irrigation tailwater return areas. Water temperatures rise above tolerances for cold water fish through most of the

[10] As discussed in Chapter 3.2, livestock grazing is a Covered Activity under the Program, but similar to some other Covered Activities it is not new; rather, it has been occurring in the Program Area for decades. Hence, authorizing livestock grazing as part of the Program will not cause the level of grazing to increase or result in any impacts in addition to those that are already part of baseline conditions in the Program Area. In fact, the Program will reduce the impacts of grazing by excluding livestock from some riparian areas by installing and maintaining fencing (see ITP and MLTC Covered Activity 5). Also, where riparian fencing is constructed as part of the Program, any grazing of livestock adjacent to the channel or within the bed, bank, or channel of the Shasta River or its tributaries may only occur in accordance with a grazing management plan that will result in improved riparian function and enhanced aquatic habitat.

reach every year and over the entire reach during many years due to tailwater input, lack of shade, and increased transit time due to reduced river volumes. Continuous water temperature monitoring conducted by the NCRWQCB at five locations along this reach during the summer (June through October) of 2003 revealed a clear increase in temperatures in a downstream direction (NCRWQCB, 2004). All five locations had weekly average water temperatures in excess of 20°C (68°F) throughout the month of July, with peak weekly average temperatures at the furthest downstream site (Yreka-Ager Road, RM 10.4) approaching 25°C (77°F) (NCRWQCB, 2004). Water temperatures throughout much of this reach also remained above suitable levels for coho salmon throughout the month of August (NCRWQCB, 2004). Similar water temperature monitoring results were obtained during the summer (June through September) of 1995 through 1997 (Deas, 1998). During a July 2003 TIR sensing survey of the Shasta River, water temperatures in the County Road A12 to Yreka Creek reach were found to be between 21°C (70°F) and 24°C (75°F) (Watershed Sciences, 2004).

There are limited areas of suitable spawning gravels present in this reach of the Shasta River. The primary salmonid use of this reach is for migration to and from more important spawning areas upstream, but adult Chinook salmon upmigration may be impeded by irrigation dams. One of 19 adult coho salmon tagged with radio telemetry transmitters in 2004 was tracked to the vicinity of County Road A12, but the fish presumably died en route to upstream spawning areas (Littleton and Pisano, 2006). Nine more tagged coho salmon migrated through the reach to spawning sites in the Dwinnell Dam to County Road A12 reach discussed above (Littleton and Pisano, 2006). In 2007, 74 percent of all tagged coho salmon adults migrated through this reach (Littleton et al., 2008). Although the reach has the potential to serve as extensive rearing habitat for juvenile salmonids (e.g., it has high productivity, some channel complexity, and relatively warm winter water temperatures), summer water temperatures typically exceed the tolerance of juvenile coho salmon. Juvenile steelhead may be able to tolerate water temperatures in some areas of this reach. Thus, this reach generally does not provide year-round coho salmon rearing habitat. Juvenile passage out of this warm reach may also be impeded during summer months by flashboard dams blocking movement upstream, and increasingly high temperatures downstream.

Current Habitat Function and Primary Limiting Factors

As discussed above, the primary function of this reach for coho salmon is that of a migratory route to and from more suitable upstream spawning and rearing grounds. Over-summer survival of juvenile coho salmon, if present, is assumed to be low due to limited cold water refugia areas, difficulty of passage upstream to reliably cold areas, and high temperatures during at least some periods of the summer. However, some steelhead may be able to utilize this reach for rearing and lampreys are likely present. Salmonid spawning in this reach is believed to be limited by poor gravel conditions.

Shasta River Canyon

The Shasta River Canyon reach extends from the Yreka Creek confluence (RM 7.75) to the Klamath River (Figure 3.3-4). A relatively steep gradient and bedrock channel substrate dominates the reach. Elevations range from 2,036 feet at the confluence with the Klamath River to 4,974 feet at Badger Peak. The watershed draining into this short reach covers 5,867 acres (approximately one percent of the total watershed area). Other than Yreka Creek, no significant tributaries join the mainstem in this reach. The Yreka Creek watershed is further described below. Rainfall varies between 18 and 30 inches. The river runs through about three miles of public lands in this reach.

Although essentially no commercial agricultural activities or significant water diversions occur here, the effects of upstream activities, including reductions in flow, increases in water temperature, and fine sediment load, are evident throughout the reach. Water diversions in this reach are limited and all known diversions are screened.

Mining activities beginning in the late 1800s stripped most of the soil and vegetation from the bedrock adjacent to the channel and subsequent livestock usage until 1991 largely prevented riparian recovery. Since 1991 significant herbaceous and woody vegetation growth has occurred in the canyon, sediment is being trapped, and the channel is gaining shade and bank complexity. Nevertheless, proximity of bedrock near the surface, as well as sudden drops in instream flows at the beginning of the diversion season, limit water availability to plants.

Water temperatures in the canyon reach are largely unsuitable for rearing juvenile coho salmon during most of the summer. From June through August 2003, the weekly average temperatures at Old Shasta Road (RM 4) were continuously higher than 20°C (68°F) with peak weekly average temperatures exceeding 25°C (77°F) (NCRWQCB, 2004). During a July 2003 TIR sensing survey of the Shasta River, water temperatures in the canyon reach were found to be between 24°C (75°F) and 26.5 °C (79.7°F) (Watershed Sciences, 2004).

Coho salmon, Chinook salmon, and steelhead use this reach for migration, spawning, and rearing. Nine of the 19 radio tagged adult coho salmon in 2004 and nine of 35 tagged adults in 2007 were recovered in the canyon reach (Littleton and Pisano, 2006; Littleton et al., 2008). CDFG personnel documented production and rearing of young-of-the-year coho salmon (CDFG, 2005). Nearly 3,300 emerging coho salmon were counted from a single capped coho salmon redd in a side channel of the canyon in 2005. However, as rearing conditions diminished due to low flows resulting from upstream irrigation withdrawals and high water temperatures, young-of-the-year coho salmon were no longer encountered in the side channel, but increasing numbers of them were captured in the rotary screw traps monitoring juvenile outmigration (Littleton and Pisano, 2006). The fate of these young-of-the-year coho salmon emigrating from the watershed is poorly understood. Unfavorable rearing conditions in the Klamath River likely result in the loss of many of these fish, but at least some are believed to migrate into tributaries to the mainstem Klamath where water temperatures are sufficiently low to allow for successful rearing.

Current Habitat Function and Primary Limiting Factors

Based on the distribution of adult spawning and the successful emergence of a large number of fry from a single capped redd, CDFG estimates that the number of juvenile coho salmon produced in the canyon reach may be equal to half the annual production of the entire Shasta River. However, while the canyon reach provides suitable habitat features for spawning and rearing in the spring, flow and temperature conditions in this reach after the onset of the irrigation season become inhospitable and force juvenile coho salmon out of the watershed (Pisano, 2007; CDFG 2005).

Parks Creek

The Parks Creek sub-watershed is approximately 35,152 acres (or seven percent of the entire watershed) and includes approximately 23.3 miles of both the West Fork and mainstem of Parks Creek. Parks Creek enters the Shasta River from the west at approximately RM 35. Elevations range from a high of 8,542 feet at China Mountain to 2,590 feet at the confluence with the Shasta River. The West Fork of Parks Creek is the only significant tributary in the sub-watershed. As one travels downstream in the watershed from the headwaters to the mouth, the glaciated valleys of the headwaters transition slowly to flat and broad alluvial fans which have formed wetlands in the lower three to four miles of the stream. Parks Creek varies from deeply incised channels in its upper reaches to a meandering stream in its lower reaches. Water flow in the creek is flashy in the winter and spring due to rain on snow events upslope. Substantial summer base flow is provided by numerous springs throughout the sub-watershed. Precipitation ranges from 55 inches annually in the headwaters, to as little as five inches near its confluence with the Shasta River.

Land use in the upper quarter of the watershed is primarily timber harvest-related in the public and private lands there. Agricultural land uses (irrigated and dryland pasture) predominate along the lower 15 miles of Parks Creek. Agricultural activity is focused primarily on pasture for cattle.

The only significant water usage in Parks Creek is for irrigation. Diversion occurs during the summer for immediate use, in winter for stock watering purposes, and in winter/spring for storage for subsequent summer use, most notably including a substantial diversion by MWCD from Parks Creek to the upper Shasta River to supplement inflows to Lake Shastina. Current records indicate that 27 diversions are located in the Parks Creek sub-watershed. Coho salmon are known or presumed to have access to 24 of those. Three diversions remain to be screened: the top two diversions and MWCD’s diversion to Lake Shastina (Beck, 2008). The irrigation season extends from March 1 to November 1 and the maximum diversion quantity identified in the decree is 46.2 cfs, although the full diversion quantity is unlikely to be available all summer. Winter diversion quantity for stock water is 16.3 cfs, and 14,000 acre-feet per year are diverted to Lake Shastina between October 1 and June 15 for storage with a maximum diversion rate of 150 cfs. China Ditch also diverts approximately 8 cfs from Parks Creek during this period (Scott, 2008).

The lower 15 miles of Parks Creek contain areas of extensive livestock impacts resulting in increased sedimentation and decreased shade. As of March 2005, no riparian fencing or other streambank protection associated with agricultural operations existed in the watershed.

The headwaters of the sub-watershed originate in the Eddy Mountains and streamflows are largely fed by snowmelt, resulting in naturally cool water conditions. From June through October 2003, the weekly average temperature in Parks Creek near its headwaters ranged from approximately 10°C (50°F) to 17.5°C (63.5°F) (NCRWQCB, 2004; 2006). However, as Parks Creek traverses the Shasta Valley toward the Shasta River, the lack of riparian vegetation, multiple water diversions, unconfined channel, and tailwater return flows raise the water temperature of the stream. Based on a one-day July 2003 thermal infrared remote sensing surveys of the Shasta River, Parks Creek added a heat load to the Shasta River that causes an increase in the surface temperatures of the Shasta River by 1.7°C just downstream of the confluence of Parks Creek (Watershed Sciences, 2004). On the day of the TIR survey, the surface water temperature at the mouth of Parks Creek was 26.6°C (79.9°F) and the surface water temperature of the Shasta River just upstream of Parks Creek was 21.4°C (70.5°F) (Watershed Sciences, 2004).

Unusually warm weather in early May 2006 caused rapid melting of an above-average snow pack in the Parks Creek watershed. High flows observed on May 19, 2006 caused the creek to spill over its banks. Flows spread across the floodplain and warmed rapidly. Although access restrictions prevented the collection of water temperature measurements in lower Parks Creek, CDFG staff measured temperatures at the Interstate 5 crossing at 11°C (52°F), on the Shasta River above Parks Creek at 12°C (53.5°F), and on the Shasta River below Parks Creek at 24°C (75°F) (Chesney et al., 2007). The event likely resulted in poor conditions for rearing coho salmon and other salmonids.

Currently both coho and Chinook salmon are known to spawn in the lower four miles of Parks Creek where limited spawning gravels exist in association with tributary springs. Two of the nineteen adult coho salmon implanted with radio tags in 2004 were tracked to Parks Creek (Littleton and Pisano, 2006). In 2007, two of 35 tagged coho salmon were tracked to Parks Creek (Littleton et al., 2008). Presumably steelhead and lampreys also use this sub-watershed for spawning. While summer utilization studies have not been conducted, water temperatures in the numerous springs feeding Parks Creek are well within the tolerance range of coho salmon and other salmonids, as are water temperatures in the higher elevation reaches where slope and velocity may or may not allow coho salmon usage. The middle and lower portions of Parks Creek exceed water temperature requirements for rearing coho salmon during most summers, although thermal refugia associated with spring inputs are known to support some juveniles through the summer (Chesney, 2008b).

Current Habitat Function and Primary Limiting Factors

Juvenile coho salmon rearing in Parks Creek is likely confined to cold water refugia associated with spring inflows.

Big Springs Creek

Big Springs Creek is approximately 2.3 miles long from the outlet of Big Springs Lake to its confluence with the Shasta River at RM 33.7 (Figure 3.3-5). Big Springs Creek (along with its only tributary, Little Springs Creek) presents one of the most visibly important components of the entire Shasta River for salmonids, as it is a major source of cold water for the Shasta River during the summer. Currently, most of the water from the spring is diverted for irrigation. Before spring of 2008, access to this reach was restricted and a definitive description of this sub-watershed is currently not available.

A single cow-calf operation, which includes a few llamas and sheep, borders Big Springs Creek and portions of the Shasta River. Land uses include wet meadow pastures, flood-irrigated pastures and dry rocky uplands. Some grass hay is cut from the natural meadows.

Documented surface water rights in Big Springs and Little Springs creeks amount to approximately 28 cfs (Webb, 2008). While Big Springs Creek typically maintains substantial flow at its confluence with the Shasta River, the entire flow of Little Springs Creek is often diverted for flood irrigation during much of the summer. Prior to the mid 1980s, in addition to the above two diversions, the Big Springs Irrigation District (BSID) also utilized a surface water diversion from Big Springs Lake, but found itself increasingly restricted in order to assure that higher priority water users further downstream received their water. Eventually the BSID drilled several relatively shallow wells and effectively abandoned their surface water right for unregulated groundwater, presumably originating from the same aquifer that feeds Big Springs Creek and the other springs in the area.

Aerial images of Big Springs Creek show there is no shade-producing vegetation along the banks and that the area tends to be heavily grazed, both in and adjacent to the channel. Remnant fences and water diversion structures suggest substantial widening of the channel. Riparian conditions are believed to be poor and degrading and no riparian exclusion fencing is in place in this area. While the wet meadow characteristics of the Big Springs Creek area was probably never conducive to substantial tree growth, those same conditions would likely have supported abundant emergent plant growth such as bulrushes and sedges, both of which would have maintained well stabilized banks and provided some shade and channel roughness.

Due to prior access restrictions in this portion of the Shasta Valley, virtually no water temperature data is currently available.[11] However, the aerial TIR investigation of the Shasta River watershed conducted in July 2003 revealed that spring influences reduced water temperatures in Big Springs Creek to approximately 15.6°C (60°F) at RM 1.9, but that downstream of the springs, temperatures increased rapidly, reaching 21.0°C (70°F) at RM 0.7 (Watershed Sciences, 2004). Based on these surveys, the NCRWQCB estimates that the overall rate of heating in Big Springs Creek is approximately 2.7°C (4.9°F)/mile with a maximum rate of heating of 4.5°C (8.1°F)/mile (NCRWQCB, 2006). By contrast, the rate of heating in the Shasta River in reaches not affected by surface water diversions was approximately 0.35°C (0.63°F)/mile at the time of the TIR survey (NCRWQCB, 2006). Aerial and TIR images of Big Springs Creek indicate that the area contains no shade-producing vegetation, tailwater returns to the creek are considerable, and the channel is substantially widened, increasing solar gain. Based on the above information, the NCRWQCB estimates that the baseline temperatures in Big Springs Creek could be reduced by approximately 4°C (7.2°F) if riparian shading were at or near site-potential conditions and the heating influence of tailwater returns was eliminated (NCRWQCB, 2006).

[11] Recently, access to perform hydrologic studies has been granted in parts of the Big Springs Creek area. Flow monitoring began on Big Springs Creek in the spring of 2008; the data collected to date is preliminary and subject to approval and quality assurance by those parties collecting and analyzing the data.

Historically (post-construction of Dwinnell Dam), between one- and two-thirds of the fall Chinook run are believed to have utilized this upper area of the Shasta River watershed, including Big Springs creek, for spawning, and presumably it was equally suitable for coho salmon (Webb, 2007). The current understanding of coho salmon use of this sub-watershed is limited, but three of 19 adult coho salmon implanted with radio tags in 2004, and three of 35 adults tagged in 2007, were tracked to Big Springs Creek (Littleton and Pisano, 2006; Littleton et al., 2008).

Current Habitat Function and Primary Limiting Factors

Although spawning adult coho salmon have been tracked to Big Springs Creek, ongoing livestock grazing in the channel poses a threat to coho salmon eggs, alevins, and fry.[12] Rearing conditions are likely variable through the reach. While some thermal refugia associated with springs are present and support some juvenile coho and steelhead rearing during the summer, current management practices in the sub-watershed have been documented to result in substantial water temperature gains in the system (see above) and present one of the best opportunities for making substantial improvement to coho salmon survival in the near term.

Little Shasta River

The Little Shasta River is approximately 26 miles long with a watershed area of approximately 51,950 acres (or approximately ten percent of the overall watershed). Elevations range from 8,241 feet at Goose Nest to 2,471 feet at the confluence with the Shasta River. Numerous intermittent tributaries enter the Little Shasta River from the north. The Little Shasta sub-watershed comprises cascade volcanics in the headwaters transitioning through a steep constrained canyon reach, and then flowing across dry flatlands in the lower 11 miles. Land along the creek varies from high mountain wet meadows in its upper reaches, through long stretches of steep ground covered with sandy volcanic ash and lava flows where timber harvest was actively engaged in, to its low gradient reaches in the Shasta Valley where agricultural activities predominate. Streamflows can be flashy in winter and spring although the very porous soils tend to minimize runoff from much of the drainage. The relatively low elevations limit snowfall and total precipitation ranges from only ten to 40 inches annually. Substantial summer base flow is provided by numerous springs in the headwaters and in the mid-reaches. Land use is primarily timber harvest related in the upper watershed and predominantly agricultural in the lower half of the watershed. In addition to public lands managed by the U.S. Forest Service (USFS) in the higher elevations, CDFG operates a wildlife area, centered near RM 4, where several manmade winter storage reservoirs, fed by a surface water diversion from the Little Shasta, provide hunting, fishing and bird watching opportunities to the public.

Agricultural activities in the Little Shasta focus on cow-calf operations, with land used for dryland and irrigated pasture, production of grass and alfalfa hay, and production of small grains for local livestock. Substantial farmable acreages exist that are largely left fallow due to a lack of sufficient water in this sub-watershed.

[12] See footnote 10.

Significant water usage in the Little Shasta is for irrigation, stock watering, municipal, and recreational uses. Diversion occurs during the summer for immediate use, in winter for stock watering and municipal purposes, and also in winter for storage for recreation and/or subsequent summer use. There are currently six screened and three unscreened agricultural diversions on the Little Shasta. Of the unscreened diversion, one is scheduled to be screened in the fall/winter of 2008. Screening of the remaining two will be accomplished by combined the two into one diversion and is currently scheduled for summer of 2009 (Davis, 2008). The summer maximum diversion quantity for irrigation is 85.6 cfs, although full diversion quantity is unlikely to be available most of any summer. The winter diversion quantity is 6.8 cfs for stock water and 8,528 acre-feet for storage.

Riparian conditions above about RM 11 are relatively good with dense overstory, tall trees, and stable banks. Between RM 11 and RM 8.75, recently installed fencing is resulting in improvements. Below RM 8.75, riparian conditions tend to be unprotected and poor. Approximately19 percent of the stream frontage on private land used by livestock is currently fenced to protect stream banks. Of the portions of the stream on USFS lands, most of the streambanks accessible to livestock have been fenced.

Continuous water temperature monitoring conducted at two locations on the Little Shasta River in late June through late October 2003 revealed weekly average water temperatures ranging between 15°C (59°F) and 20°C (68°F) at Ball Mountain Road (RM 10) during much of July and August, and temperatures between 20°C (68°F) and 25°C (77°F) at the mouth of the Little Shasta River during the same period (NCRWQCB, 2004). The aerial TIR investigation of the Shasta River watershed conducted in late July 2003 indicated an average median water temperature in the Little Shasta River of 28°C (82°F) between RM 11.3 and the confluence with the Shasta River (Watershed Sciences, 2004). During the survey, very little visible surface flow was present in the Little Shasta River throughout much of the survey extent.

Current Habitat Function and Primary Limiting Factors

Until recently, the Little Shasta River was only known to be used intermittently by fall-run Chinook salmon and steelhead when early rains or irrigation cessation resulted in water conditions that allowed them to migrate upstream. However, CDFG staff encountered juvenile coho salmon in the creek in 2006 (Whelan, 2007). Reaches containing suitable spawning gravels occur primarily upstream of RM 10. However, little is known regarding the use of the watershed by coho salmon, and the largely dry condition during the summer months likely preclude year-round juvenile rearing below RM 10.

Yreka Creek

The Yreka Creek sub-watershed comprises about 12 miles of Yreka Creek and six miles of Greenhorn Creek, its only significant tributary. The total watershed acreage is approximately 33,450 acres (or 6.6 percent of the overall watershed area) and elevations range from a high of 5,810 feet on the ridge shared by Yreka and Greenhorn creeks with the Scott Valley, down to 2,387 feet at the confluence with the Shasta River at RM 7.75. The creek varies from steep and deeply incised in its upper reaches to a near-surface stream in its alluvial lower reaches. The portion of the creek flowing through the City of Yreka has been channelized to a significant degree. Downstream of Yreka, the floodplain was severely degraded by dredge mining prior the 1950s, at which time the dredge tailings were leveled, and a channel was created for the stream at the base of the hills bordering the east side of the historic floodplain. Precipitation ranges from 40 inches annually in the headwaters of Greenhorn Creek, to 18 inches near the confluence with the Shasta River. Summer thunderstorms can result in very flashy flows in mid-summer, and on rare occasions rain-on-snow events can produce high water in winter. Land use is primarily timber harvest in the upper watershed, grading into rural residential near the base of the hills, and agricultural land use (irrigated and dryland pasture) and urban areas in the valley bottom. The City of Yreka is in the center of the watershed. The City owns and operates Greenhorn Reservoir built near the mouth of Greenhorn Creek. Historically Greenhorn Creek appears to have been the primary gravel source for Yreka Creek and the lower Shasta River, a function now precluded by the reservoir.

Agricultural use in the watershed is limited and consists of irrigated and partially irrigated fields in the bottomlands bordering Yreka Creek (but not Greenhorn Creek) both upstream and downstream of the City of Yreka. Those fields are grazed while forage and water is available, but livestock are moved elsewhere later in the season.

No active surface water diversions are believed to be located within the current range of coho salmon within this sub-watershed. Approximately nine active diversions capture the available water in the headwaters of Yreka Creek, although runoff there appears to be largely seasonal. Runoff in Greenhorn Creek is captured by Greenhorn Reservoir, which does not provide fish passage. Residents living outside of town capture underflow of both Yreka Creek and Greenhorn Creek for domestic and/or irrigation uses. The City of Yreka imports up to 6 cfs from Fall Creek on the Klamath River for domestic use, but supplements that water with water from the underflow of Yreka Creek during times of peak demand in mid-summer. At the same time, the city’s waste water treatment plant supplements flows of Yreka Creek, along with supplementing its surface and underflow with secondarily treated waste water. Peak potential diversion quantities equal 9.88 cfs, not including any water captured by Greenhorn Reservoir or in Greenhorn Creek upstream of the reservoir. Some water usage is believed to be occurring from Humbug Creek, a small and usually disconnected tributary which might otherwise reach Yreka Creek and provide for surface or subsurface flows (SVRCD, 2005). Diversions in Yreka Creek are not watermastered.

Riparian conditions in the upper five miles of Yreka Creek are generally poor as a result of ongoing grazing impacts[13] and loss of most of what little water would be in the stream in mid- to late summer to support riparian growth. The lower seven miles of Yreka Creek are in generally good condition in terms of riparian vegetation, but the stream is overly constrained to a fixed channel with limited opportunities for habitat variability, particularly in the absence of its historic supply of gravel. Riparian fencing in this sub-basin is largely non-existent (Webb, 2008).

13 See footnote 10.

Only limited water temperature data is available for Yreka Creek. The maximum temperature recorded in 2001 (sampling period and location unknown) is reported by the NCRWQCB (2006) as 28.4°C (83°F) while the maximum weekly average temperature was 24.4°C (76°F). Temperatures measured in late July 2003 during the aerial TIR investigation were 23.4°C (74°F) at the mouth of Yreka Creek (Watershed Sciences, 2004).

Chinook salmon can be found spawning in the lower four miles of Yreka Creek in years when creek flows are high enough in the fall to allow for adult access. Steelhead are also known to spawn in Yreka Creek. One tagged adult coho salmon was tracked to RM 2.5 in Yreka Creek in 2007 (Littleton et al., 2008) and juvenile coho salmon were reported from CDFG electrofishing surveys conducted on Yreka Creek in 2002 (Whelan, 2007). Juvenile coho salmon and steelhead are found over-summering in Yreka Creek where pockets of cold water persist through the summer. Cold water sources include some small springs within the city limits of Yreka, and seepage from the City of Yreka sewage treatment plant.

Current Habitat Function and Primary Limiting Factors

Coho salmon use and habitat conditions in the Yreka Creek watershed have not been thoroughly investigated. Adult coho salmon access to the creek is likely limited by low flows. Juvenile rearing habitat appears to be restricted to a few cold water refugia.

Limiting Factors

A detailed limiting factors analysis for coho salmon and the CDFG fish species of special concern in the Shasta River watershed has not been prepared. However, a number of surveys and studies have been conducted over the past decade, focusing on fisheries population data, habitat extent, and water quality conditions. Combining the results and observations summarized in these studies with the known habitat preferences and physiological requirements of coho salmon and the CDFG fish species of special concern allows us to identify suboptimal habitat conditions that are prevalent in the watershed and that, if addressed appropriately in future management efforts, may help, at a minimum, to stabilize salmonid populations and possibly aid in the recovery of coho salmon. While the majority of these factors have been mentioned in the previous descriptions of the various sub-watersheds, the discussion presented below summarizes the current understanding of the primary features of existing aquatic habitat impairment in the Shasta River watershed.

Streamflows

As discussed in Chapter 3.2, Geomorphology, Hydrology, and Water Quality, in this Draft EIR, the present hydrologic regime of the Shasta River is affected by surface water diversions, groundwater pumping, and Dwinnell Dam. Runoff peaks generally occur during the winter and late spring and are associated with rain and/or rain-on-snow events. Flows decline rapidly with the onset of the irrigation season in March and April, which reduces baseflow volumes during the spring and summer months. Flow slowly begins to increase in September and October when most of the seasonal irrigation diversions cease. Winter baseflow conditions typically are 180 to 200 cfs, regardless of precipitation, and similar flows probably existed historically throughout the year (NRC, 2004). Surface diversions and loss of flow from springs due to groundwater withdrawals have reduced summer flows to approximately ten percent of their historic rates (NRC, 2004). Figure 3.2-7, presented in Chapter 3.2, depicts unimpaired flow estimates in comparison to measured flow volumes for the Shasta River from 2002-2005.

As discussed previously, suitable streamflows throughout the year are important for the various life stages of coho salmon, Chinook salmon, and steelhead. Streamflows need to be sufficiently deep and continuous for adults to complete their migration from the ocean to freshwater spawning grounds unimpeded. Excessive water velocities during the winter and spring incubation and emergence period may scour out redds or flush fry out of the drainage. Spring flows must be sufficient to allow for incubation of eggs and alevins, to provide edge habitat for newly emerged fry, and to enable smolt emigration. Low summer base flows reduce effective juvenile rearing habitat availability, may result in water temperature increases, and can cause stress or mortality to riparian vegetation.

Intuitively, the reduction of streamflow associated with water diversions reduces the overall volume of water available to fish and results in adverse effects to fish through habitat loss and/or degradation. However, the effects of variations in streamflow on fish survival and growth can be difficult to estimate because of the possible confounding effects of associated increases in water temperature and population densities (Harvey et al., 2006). Nevertheless, some research has been conducted on these effects. For example, researchers studying the effect of streamflow on survival and growth of resident rainbow trout by manipulating streamflows entering experimental and control reaches in a small stream in northwestern California found that the mean body mass of fish in control units increased about 8.5 times as much as that of fish in units with reduced streamflow (Harvey et al., 2006).

A reduction in habitat availability is the most obvious effect of water diversions and the relationship between streamflow and habitat availability has been investigated in numerous studies. For example, an Instream Flow Incremental Methodology (IFIM) study of lower Scott Creek in Santa Cruz County, found that optimum habitat conditions for juvenile steelhead and coho salmon in Scott Creek are provided at 20 cfs, and that only half of the maximum habitat remains at 5-6 cfs (Snider et al., 1995). Nevertheless, while habitat availability is a measurable parameter, the response of fish to reduced habitat availability is more difficult to quantify.

CDFG studies in the lower Shasta River in 2005 documented a substantial loss of suitable rearing habitat and the displacement of rearing age 0+ coho salmon as a result of streamflow reductions associated with the April 1 onset of the diversion season (CDFG 2005, Chesney et al., 2007). Nearly 3,300 emerging coho salmon were counted from a single capped coho salmon redd in a side channel of the canyon in 2005. However, after April 1, flows diminished rapidly as a result of upstream irrigation withdrawals and young-of-the-year coho salmon were no longer encountered in the side channel, but increasing numbers of them were captured in the rotary screw traps monitoring juvenile outmigration (Littleton and Pisano, 2006). Measurements of habitat extent conducted at the time of the redd capping investigation showed that up to fifty percent of available rearing habitat was lost in a side channel of the Shasta River canyon reach when streamflow in the side channel was reduced from 41.4 cfs on February 23, 2005 to 20.5 cfs on April 5, 2005 (CDFG, 2005). These results provide a strong indication that coho salmon fry produced in the Shasta River canyon, and potentially elsewhere in the watershed, are being forced out of the system by decreased streamflows resulting from surface water diversions. Similarly, a year-long study conducted by the Center for Watershed Sciences at the University of California at Davis during water year 2007 (October 1, 2006 through September 30, 2007) showed that while juvenile coho salmon, Chinook salmon, and steelhead were all present within the mainstem Shasta River between RM 27.5 and RM 32.0 during the spring season, primarily juvenile steelhead remained in the reach over the summer (Jeffres et al., 2008). Some level of coho salmon and Chinook salmon absence from this reach after the spring can presumably be attributed to natural smolt outmigration, but only one age 0+ coho salmon was observed in this reach after the irrigation season had started, suggesting that even young-of-the-year juveniles emigrated from the reach. Increased water temperatures and reduced habitat availability attributable to the diversions are believed to have played an important role in the summer absence of rearing juvenile coho salmon (Jeffres et al., 2008).

Another effect of habitat reduction associated with water diversions, if all other factors remain constant, is an increase in population density. Studies of varying densities of rearing juvenile coho salmon in hatcheries have found that an increase in fish density was associated with significant decreases in weight, length, condition factor, and food conversion efficiency; elevated body water content; reduced fat and protein contents; and increased mortality (Fagerlund et al., 1981). While this study was not conducted in a natural setting and may therefore not be directly applicable to density variations in streams and rivers, the fact that a hatchery experiment allows for control of all parameters (e.g., food supply, temperature) eliminates some of the confounding effects inherent in natural settings.

The reduction of water may also result in increased inter-specific fish densities in natural settings. For example, steelhead and coho salmon are known to be significant competitors for resources when not segregated by natural habitat diversity and preference. Steelhead densities have been shown to have a negative effect on coho salmon growth as measured in weight change. Harvey and Nakamoto (1996) showed that weight change in coho salmon was positive among fish held in the absence of steelhead, neutral among coho salmon held with natural steelhead densities, and negative among those held in twice the natural steelhead densities. The more aggressive coho salmon typically dominate interactions among similar-sized juvenile salmonids (Moyle, 2002). However, Moyle (2002) points out that "when habitat conditions in California streams favor juvenile steelhead so that their densities are higher than those of coho, growth of coho may be suppressed through competition for food in crowded pools, especially when flows are low, and through aggressive interactions with large 1- to 2-year-old steelhead."

In addition to habitat loss, reduced streamflows can result in the direct mortality of certain life stages of coho salmon. Particularly during below-average water years, streamflows in the Shasta River decrease rapidly after the onset of the diversion season (CDFG, 2005) and CDFG speculates that if 2005 had been a below-average water year, the capped redd that produced almost 3,300 coho salmon fry discussed above would have likely been dewatered and most, if not all, of its fry would have perished (Pisano, 2007).

Along with excessive water temperatures discussed below, impaired streamflows are likely the most significant factor limiting coho salmon and the CDFG fish species of special concern in the Shasta River watershed. It is important to recognize that the effects of water diversions on coho salmon and the other CDFG fish species of special concern and their habitats are in many instances the cumulative result of the water diversions in total throughout the watershed. While some individual diversions might not significantly affect fisheries resources and their habitat because, for example, they are already screened or the amount of water diverted is small, the total volume of water diverted in the watershed results in degraded conditions that contribute to mortality and other adverse impacts to fisheries resources and aquatic habitat quality within the Program Area. This is another reason the Program is watershed-wide.

Water Quality

Coho salmon and other salmonid species are dependent on suitably low water temperatures and adequately high dissolved oxygen concentrations. Increased water temperatures and low dissolved oxygen levels decrease the area and volume of suitable habitat for salmonids, decrease survival during incubation, rearing, and migration, and can be lethal. In the Shasta River basin, elevated temperatures and low dissolved oxygen contribute to the non-attainment of beneficial uses associated with the cold water fishery, specifically the salmonid fishery (NCRWQCB, 2006).

As discussed above, much of the Shasta River downstream of the GID diversion, as well as the tributaries known to be used by coho salmon for spawning, exhibit summer water temperatures that are at the upper end or in excess of coho salmon temperature preferences, although species with a higher temperature tolerance (Chinook salmon and steelhead) have been noted to experience high growth rates within a 4.5-mile reach of the mainstem Shasta River (RM 27.5 to RM 32.0) immediately downstream of the GID diversion (Jeffres et al., 2008). Water temperatures influence rearing juveniles' growth rate, population density, swimming ability, ability to capture and metabolize food, and ability to withstand disease.

During the spring and summer of 2008, CDFG staff conducted surveys of the upper Shasta River (above RM 32) and its tributaries, Big Springs Creek and Parks Creek, to determine the location and thermal characteristics of summer rearing habitat utilized by juvenile coho salmon. From the beginning of the surveys in March through late August, CDFG staff observed a decrease in the distribution and number of rearing coho salmon and noted that the only locations where juveniles continued to rear in late summer were near, or downstream of, cold water springs (Chesney, 2008a). Preliminary results of the investigation suggest that water diversions reduce instream habitat and the warm tailwater returns displace juvenile coho salmon from areas that had been suitable earlier in the season (Chesney, 2008b).

Although historic water temperature data for the Shasta Valley is not available,[14] several factors that are widely understood to cause increases in stream temperatures exist in the watershed. The NCRWQCB identified limited riparian shading, tailwater return flows, surface water diversions,

[14] Jeffres et al. (2008) cite currently unpublished modeling results estimating pre-development hydrologic and thermal conditions of the Shasta River at the Nelson Ranch property (RM 27.5 to RM 32.0). Published reports of the modeling results for the entire watershed were not available at the time of Draft EIR preparation.

groundwater accretion, and the effects of Lake Shastina and minor impoundments as factors affecting water temperatures in the Shasta River watershed (NCRWQCB, 2006). A lack or scarcity of riparian cover, as is the current condition in much of the Shasta Valley, allows increased solar radiation to reach the water surface, resulting in gradual temperature gains. Tailwater returns add heated water to the river and tributaries. In one instance, water temperatures of a tailwater return on Big Springs Creek were shown through aerial infrared imaging to be 9.2°C warmer than temperatures in the creek (NCRWQCB, 2006). Furthermore, reduced water volumes and velocities resulting from diversions typically allow water temperatures to rise. Aerial infrared imaging revealed that the locations of several diversions on the Shasta River coincide with increases in the rate of heating in the river (NCRWQCB, 2006). Conversely, temperature models completed for the Shasta River suggest that the addition of 20 cfs of cold water flow to the current August baseline flows would reduce maximum water temperatures in the middle and lower reaches of the Shasta River by 2 to 3°C (Watercourse Engineering, 2003) and that the addition of 45 cfs of cold water flow below the confluence of Big Springs Creek would result in reductions of maximum water temperatures by as much as 6°C at the Yreka-Ager Road crossing (NCRWQCB, 2006).[15] Water diversion structures, particularly dams, also contribute to rises in summer water temperatures due to slowing water velocities upstream of the dams. Thus, it is evident that agricultural water diversions in the Shasta River watershed are at least partly responsible for observed warm water conditions in the late summer and early fall. Along with impaired streamflows, excessive water temperatures are likely the most significant factor limiting coho salmon survival in the Shasta River watershed.

In addition to excessive water temperatures during critical juvenile rearing periods, the Shasta River has been designated as impaired for dissolved oxygen concentrations by the NCRWQCB (2006). Dissolved oxygen concentrations of 8 mg/L or higher are typically considered ideal for rearing salmonids including coho salmon. Rearing juveniles may be able to survive when concentrations are relatively low (e.g., less than 5 mg/L), but growth, metabolism, and swimming performance are adversely affected (Bjornn and Reiser, 1991). The Water Quality Control Plan for the North Coast Region (Basin Plan) (NCRWQCB, 2005) objective for the Shasta River and its tributaries is 7 mg/L. Factors contributing to changes in dissolved oxygen concentrations include photosynthesis and respiration of aquatic plants, respiration of aerobic organisms including bacteria that decompose organic material, concentrations of oxygen-consuming constituents, flow, velocity, and water temperature. The NCRWQCB (2006) found that during the fall and winter seasons (October 1 through March 30), dissolved oxygen concentrations in the Shasta River generally range from 7 to 19 mg/L, and during the spring and summer seasons (April 1 through September 30), concentrations range from 2 to 18 mg/L. Thus, some areas of the Shasta River watershed do not provide suitable dissolved oxygen levels for coho salmon during the spring and summer period.

[15] NCRWQCB (2006) estimate assumes that water temperatures in Big Springs Creek and Parks Creek are reduced by 4°C and 2°C, respectively, through increased riparian shading, elimination of tailwater return, and, in the case of Parks Creek, a reduction in water diversions.

Habitat Features

Salmonid species' need for habitat features such as LWD, pool availability and depth, and channel complexity are discussed above. No recent focused habitat inventories of the entire Shasta River watershed have been conducted, although a habitat typing study was conducted on the lower ten miles of the Shasta River in the late 1980s (West et al., 1990). Within the lowland valley portion of the watershed, riparian and instream cover are scarce, fine sediment levels are high (Ricker, 1997), and water temperatures are high. Nevertheless, suitable habitat conditions for coho salmon and CDFG fish species of special concern remain in some reaches. For example, researchers studying a 4.5-mile reach of the mainstem Shasta River (RM 27.5 to RM 32.0) downstream of the GID diversion concluded that this reach provides unique and potentially very high quality habitat for rearing juvenile salmonids (Jeffres et al., 2008). However, while species with a higher temperature tolerance (Chinook salmon and steelhead) experience high growth rates in this reach, water temperatures are believed to be a limiting factor for juvenile coho salmon despite the abundance of available habitat (Jeffres et al., 2008).

Migration Barriers

Barriers to adult up-migration, smolt out-migration, and juvenile intra-watershed migration may be complete and relatively permanent, such as in the case of Dwinnell Dam, but are more often partial and temporary, such as low flow migration impediments (e.g., Little Shasta River, Yreka Creek). Structural impediments such as flashboard dams are in many instances partial barriers as they may block intra-watershed movement of juveniles during the summer months but are typically removed at the end of the irrigation season in time for the majority of the adult spawning migration except when the diverter has stock water rights. Within the Shasta River watershed, Dwinnell Dam represents the most significant migration barrier for coho salmon, effectively eliminating an estimated 22 percent of the total spawning habitat formerly available to salmon and steelhead (Wales, 1951). Along with impaired streamflows and excessive water temperatures, Dwinnell Dam is likely one of the most significant factors limiting coho salmon and CDFG fish species of special concern in the Shasta River watershed.

Coho Salmon Brood Year Lineages

While evaluating the known and potential effects that the factors discussed above have on limiting coho salmon productivity within the watershed, it is important to keep the rigid three-year life cycle of coho salmon in mind. Although aquatic habitat conditions in the Shasta River and its tributaries have been impaired by land use practices over the past 100 years, outmigration studies conducted by CDFG resulted in population estimates of approximately 10,800 smolts emigrating from the watershed during the spring 2006 migration period compared to approximately 1,800 smolts during the spring of 2004 (Chesney et al., 2007). Smolts captured in 2006 were hatched in the spring of 2005 and are thus members of the one remaining strong brood lineage (2001…2004…2007). The 2006 smolt data, as well as data collected on returning adults (2004), suggest that even though coho salmon populations have experienced declines over historic numbers, the watershed is capable of producing relatively large numbers of juvenile coho salmon when sufficient numbers of adults return to the system to spawn and flows are adequate. One of the most important factors in the low numbers of coho salmon observed during two out of every three years may therefore be the low population numbers in and of themselves. Severely depressed brood lineages require a long period of time to recover and regain historic population sizes, even if habitat conditions are ideal and, conversely, a relatively strong brood lineage perpetuates itself even in less than ideal conditions.

It should also be noted that prior to 2007, many other coastal watersheds in California showed similar coho salmon population trends consisting of a strong 2001…2004…2007 brood lineage and weak 1999…2002…2005 and 2000…2003…2006 lineages (e.g., Smith, 2002).[16] Thus, the decline in coho salmon populations is at least partially a result of conditions or events that are not specific to any given watershed. Some of these factors are discussed below.

External Factors

While the limiting factors discussed above pertain primarily to conditions affecting coho salmon within the Shasta River watershed, the anadromous life history of salmonids and lampreys also exposes the species to factors outside the Program Area, including ocean conditions, migratory conditions in the Klamath River, climate conditions, and a number of highly variable factors. For example, recent studies have documented significant mortality in juvenile salmon and steelhead populations in the Klamath River due to infectious disease, primarily caused by the endemic parasites *Ceratomyxa shasta* and *Parvicapsula minibicornis*. In 2004, infection rates in juvenile Chinook salmon ranged from about 20 to 70 percent for *C. shasta* and from 40 to 96 percent for *P. minibicornis*. In 2005, dual infection rates at or near 100 percent were observed for consecutive weeks in April, a critical period for outmigration of juvenile anadromous fishes (USFWS, 2007).

Although freshwater habitat loss and degradation have been identified as leading factors in the decline of anadromous salmonids in California, climatic variations such as droughts, floods, and ocean conditions also affect these species. For example, a strong correlation between salmon abundance, as measured in annual catch, and Pacific Decadal Oscillation (PDO) cycles has been shown by researchers (Mantua et al., 1997). A warm phase PDO is typically associated with reduced abundance of coho and Chinook salmon in the Pacific Northwest, while cool phase PDO is linked to an above average abundance of these fish (Mantua et al., 1997). A marked decline in the 2007 coho and Chinook salmon returns was observed throughout the species' range in California and elsewhere along the Pacific coast (McFarlane et al., 2008). A recently developed ocean conditions index, the Wells Ocean Productivity Index (WOPI), reveals poor conditions during the spring and summer of 2006, when juvenile coho salmon from the 2004...2007 brood lineage entered the ocean (McFarlane et al., 2008).

[16] The cited document states that only the "1993, 1996, 1999, 2002 year class" remains strong. However, this assessment is based on data collected during surveys of rearing juveniles. Thus the "2002 year class" is equivalent to the 2001 brood lineage.

3.3.2 Regulatory Framework

Federal and State Regulation of Special-Status Fish Species and CDFG Fish Species of Special Concern

Endangered Species Act

Under ESA, the Secretaries of the Interior and Commerce have joint authority to list a species as threatened or endangered (16 U.S.C. § 1533[c]). ESA prohibits take of endangered or threatened fish and wildlife species on private property, and from take of endangered or threatened plants in areas under federal jurisdiction. Under ESA, "take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." USFWS and NMFS define "harm" in their regulations to include significant habitat modification that could result in take of a species. If a project would result in take of a federally-listed species, either an incidental take permit under ESA section 10(a), or an incidental take statement issued pursuant to federal interagency consultation under ESA section 7 is required prior to the occurrence of any take. Such authorization typically requires various measures to avoid and minimize take and, if necessary, to compensate for take.

Pursuant to the requirements of ESA section 7, a federal agency reviewing a proposed project that it might authorize, fund, or carry out, must determine whether any federally-listed threatened or endangered species, or species proposed for federal listing may be present in the project area and determine whether implementation of the proposed project is likely to affect the species. In addition, the federal agency is required to determine whether a proposed project is likely to jeopardize the continued existence of a listed species or any species proposed to be listed under ESA or result in the destruction or adverse modification of critical habitat proposed or designated for such species (16 U.S.C. § 1536[3], [4]).

NMFS administers ESA for marine fish species, including anadromous salmonids such as coho salmon, and USFWS administers ESA for non-marine species. Projects where a federally-listed species and/or its habitat are present and are likely to be affected by the project must receive authorization from either NMFS or USFWS. Authorization may involve a letter of concurrence that the project will not result in the potential take of a listed species and/or its habitat or it may result in the issuance of a Biological Opinion that describes measures that must be undertaken in order to minimize the likelihood of an incidental take of a listed species. Where a federal agency is not authorizing, funding, or carrying out a project, take that is incidental to the lawful operation of a project may be permitted pursuant to ESA section 10(a).

California Endangered Species Act

CESA (Fish and Game Code, § 2050 *et seq.*) prohibits take[17] of an endangered, threatened, or candidate species unless the take is authorized by CDFG. CDFG may authorize take by permit provided: 1) it is incidental to a lawful activity; 2) the impacts of the authorized take are

[17] "Take" means hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (Fish and Game Code, § 86).

minimized and fully mitigated; 3) the permit is consistent with any regulations adopted pursuant to Fish and Game Code, §§ 2112 and 2114; 4) there is adequate funding to implement the minimization and mitigation measures, and to monitor compliance with and the effectiveness of those measures; and 5) issuance of the permit will not jeopardize the continued existence of the species (Fish and Game Code, § 2081, subds. (b), (c)). Under CESA, the Commission maintains the lists of threatened species and endangered species (Fish and Game Code, § 2070). The Commission also maintains a list of candidate species for which CDFG has issued a formal notice as being under review for addition to either the list of endangered species or threatened species.

Fish and Game Code, § 1600 et seq.

Under Fish and Game Code, § 1600 *et seq.*, CDFG regulates activities that will "substantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of any river, streams and lakes, or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake." Before an entity may begin such an activity, it must notify CDFG and describe the activity. If CDFG determines that the activity described in the notification could substantially adversely affect an existing fish or wildlife resource, the entity must obtain a Streambed Alteration Agreement (SAA) before conducting the activity, which will include measures CDFG determines are necessary to protect the fish and wildlife resources the activity could affect.

Fish and Game Code, § 5901

Fish and Game Code, § 5901 makes it "unlawful to construct or maintain in any stream … any device or contrivance that prevents, impedes, or tends to prevent or impede, the passing of fish up and down stream."

Fish and Game Code, § 5937

Fish and Game Code, § 5937 requires "the owner of any dam [to] allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around or through the dam, to keep in good condition any fish that may be planted or exist below the dam."

Goals and Policies

The Klamath Fishery Management Council

The Klamath Fishery Management Council (KFMC) was an 11-member federal advisory committee which included representatives from commercial and recreational ocean fisheries, the in-river sport fishing community, tribal fisheries, and state and federal agencies (CDFG, Oregon Department of Fish and Wildlife, NMFS, and U.S. Department of the Interior) that worked by consensus to manage harvests and ensure continued viable populations of anadromous fish in the Klamath Basin. KFMC developed a long-term plan for the management of in-river and ocean harvest of Klamath Basin anadromous fish.

Before the Klamath Act expired in 2006, the KFMC met three times each spring to review the past year's harvest of Chinook salmon, and to review predictions of Chinook salmon ocean abundance and harvests in the upcoming year developed by their Technical Advisory Team. KFMC then made specific recommendations to the agencies that regulate the harvest of Klamath Basin fish. These agencies include the Pacific Fishery Management Council (PFMC), Commission, Oregon Department of Fish and Wildlife, Yurok Tribal Fisheries, and Hoopa Tribal Fisheries. KFMC recommendations to PFMC were used to develop ocean salmon fishing seasons. PFMC then passed its recommended fishing seasons to the Department of Commerce, which has final authority in setting regulations for the ocean fishery.

In 2006 and 2007, PFMC severely limited the allowable catch of salmon off the California and Oregon coasts, in order to protect the depleted Klamath stocks. For 2008, PFMC took the unprecedented action of completely closing the salmon fishing season off the California coast due to severely depressed Sacramento River stocks. While the intent of the restrictions is to rebuild salmon stocks, they have also had the consequence of impairing the commercial, recreational, and tribal salmon fisheries.

Siskiyou County General Plan

The Conservation Element of the Siskiyou County General Plan includes general objectives relating to biological resources. These objectives include "to preserve and maintain streams, lakes and forest open space as a means of providing natural habitat for species of wildlife." There are no Habitat Conservation Plans or other approved habitat plans that apply to lands within the Program Area.

3.3.3 Impacts and Mitigation Measures

Significance Criteria

To determine the level of significance of an identified impact, the criteria outlined in the CEQA *Guidelines* and Appendix G in the CEQA *Guidelines* were used. The following is a discussion of the approach used to determine whether the Program could have a significant effect on fisheries and aquatic habitats.

Under CEQA *Guidelines,* § 15065(a), if a project "has the potential to substantially degrade the quality of the environment; substantially reduce the habitat of a fish and wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community; substantially reduce the number or restrict the range of an endangered, rare or threatened species,"[18] the lead agency must prepare an EIR for the project (CEQA *Guidelines,* § 15065, subds. (a), (a)(1)). CEQA *Guidelines,* § 15206(b)(5) specifies that a project shall be deemed to be of statewide, regional, or area-wide significance if it "would substantially affect sensitive wildlife habitats including but not limited to riparian lands, wetlands, bays, estuaries, marshes, and habitats for rare and endangered species as defined by CEQA *Guidelines,* § 15380"

18 "Endangered, rare, or threatened species" is defined in the Glossary.

(California Code Regulations, title 14, § 15065, subd. (b), (b)(5)). “Endangered, rare, or threatened species” and species that meet the definition of an endangered, rare, or threatened species under CEQA *Guidelines*, § 15380 are collectively referred to as special-status species in this Draft EIR.

In addition to the significance criteria in Appendix G for biological resources (discussed below), for the purpose of this analysis, the criteria in CEQA *Guidelines*, §§ 15065(a)(1) and 15206(b)(5) were used to determine whether any effect of the Program on fisheries and aquatic habitats could be significant. Hence, any effect of the Program that would “substantially degrade the quality of the environment,” “substantially reduce the habitat of a fish or wildlife species,” and/or “substantially affect sensitive wildlife habitats,” constitute a significant effect for the purpose of this impact analysis. The Program would “substantially degrade the quality of the environment” if it could render currently suitable fisheries habitat unsuitable (e.g., fine sediment deposition at levels that would impair salmonid spawning). The Program would “substantially reduce the habitat of a fish or wildlife species” if it could cause an overall reduction in current habitat availability (e.g., through migration barriers) or suitability (e.g., through increases in water temperature). The Program would “substantially affect sensitive wildlife habitats” if it could adversely alter the current use of a fisheries habitat area (e.g., fine sediment deposition at levels that would impair salmonid spawning). Also for the purpose of this impact analysis, an overall reduction of the current extent or ecological function of fishery habitat caused by the Program would constitute a “substantial, or potentially substantial, adverse change in . . . the physical conditions [in the Program Area],” and therefore would be considered a significant effect (CEQA *Guidelines*, § 15382).

In accordance with Appendix G in the CEQA *Guidelines*, the Program would have a significant effect on the environment if it could:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG or USFWS (or NMFS in the case of marine and anadromous species). For purposes of this analysis, substantial adverse effects on species are defined as effects that result in mortality of a substantial number of individuals or habitat modifications that would reduce the overall suitability of the habitat.

- Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by CDFG or USFWS (or NMFS in the case of marine and anadromous species). For purposes of this analysis, substantial adverse effects on sensitive natural communities are defined as effects that result in the overall reduction of the current extent or ecological function of the community.

- Have a substantial adverse effect on federally protected wetlands as defined by Clean Water Act section 404 (including, but not limited to, marshes and vernal pools) through direct removal, filling, hydrological interruption, or other means. For purposes of this analysis, substantial adverse effects on federally protected wetlands are defined as effects that result in the overall reduction of the current extent or ecological function of wetlands.

- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites. For purposes of this analysis, substantial interference with the movement of fish species are defined as effects that permanently block (e.g., dams) or seasonally impede (e.g., insufficient water depths) fish movement.

- Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance. For purposes of this analysis, a fundamental conflict with a local plan or ordinance is defined as any action that substantially conflicts with the terms of such policies or ordinances.

- Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan. For purposes of this analysis, a fundamental conflict with an adopted habitat conservation plan is defined as any action that would substantially conflict with the terms of such a plan.

Impact Analysis

As discussed earlier in this Draft EIR, some of the activities the Program proposes to authorize through the issuance of SAAs and sub-permits are historic, ongoing activities that, along with the impacts they have had on the physical conditions in the Program Area, are part of the existing environmental setting. These include water diversions that the Program proposes to authorize to bring them into compliance with Fish and Game Code, § 1600 *et seq.* and CESA. As a result, authorizing existing water diversions and the activities related to them will not further degrade the physical conditions in the Program Area or elsewhere, or cause the number of water diversions or the amount of water diverted to increase. In fact, it is expected that the overall amount of water diverted in the Program Area will decrease at certain times of the year after the Program is implemented due to the terms and conditions in the SAAs, ITP, and sub-permits that CDFG issues under the Program. Further, the existing water diversions and related activities will continue whether or not the Program is implemented. However, by implementing the Program, the fisheries and aquatic habitat conditions are expected to improve as a result of the implementation of many of the terms and conditions in the SAAs, ITP, and sub-permits that CDFG would issue under the Program. Those terms and conditions are described in Chapter 2 and Appendices A and B of this Draft EIR. Again, it is important to emphasize that these terms and conditions are not mitigation measures CDFG has identified to reduce the level of impacts to less than significant as required by CEQA; rather they are measures which avoid and minimize impacts in accordance with the Program participants' statutory obligations under Fish and Game Code, § 1600 *et seq.* and CESA.

Impact 3.3-1: Construction, maintenance, and other instream activities associated with various Covered Activities may result in impacts to fisheries resources and their habitat (Significant).

In addition to the discussion below, please refer to the similar description of impacts and mitigation measures from a hydrological perspective under Impact 3.2-1 in Chapter 3.2.

Implementation of several of the Covered Activities would involve new construction activities within stream channels and/or upland areas in close proximity to channels. Instream construction activities would be required for projects that involve the construction of new headgates, fish screens, stream access and crossings, instream habitat structures, and barrier removal/fish passage, as well as the maintenance and repair of existing structures (e.g., due to flood damage). Projects requiring construction and maintenance activities in upland or floodplain areas include the installation of fencing and riparian restoration/revegetation.

Most of these construction and maintenance activities would require some degree of ground clearing, channel and bank excavation, backfilling, earthmoving, stockpiling and/or compaction, grading, and concrete work. These activities may result in the following significant impacts to coho salmon, CDFG fish species of special concern, and other fisheries resources:

Short-term increases in sedimentation and turbidity. Increased sedimentation rates could result if fine sediment is discharged to streams or mobilized within channels during project activities. Increased sedimentation may adversely affect water quality and channel substrate composition. Specific rates of sedimentation are dependant upon the duration, volume, and frequency at which sediments are contributed to the surface water flow. Substantial sedimentation rates may smother fish eggs and fish food (i.e., benthic invertebrates), degrade spawning habitat, and fill pools. Furthermore, suspended sediments increase the turbidity of the water. High rates of turbidity can result in direct mortality or deleterious sublethal effects (e.g., gill abrasion, decreased visibility during foraging) to fish.

Accidental spills and use of hazardous materials. Equipment refueling, fluid leakage, and maintenance activities within or near-stream channels pose a risk of accidental water contamination that may result in injury or death to coho salmon and other fish species. Many commonly used hydraulic fluids contain organophosphate ester additives that are toxic to salmonids and other fish species. Acute lethal and sublethal effects have been documented in salmonids in particular (as opposed to warm water species). Leaks or spills of petroleum hydrocarbon products found in construction equipment have similar adverse effects on fish.

Furthermore, when surface water comes into contact with uncured concrete, either through accidental spills of concrete or through contact with recently-poured structures (e.g., headgates, fish screens), alkaline substances in the concrete may leach into the water, resulting in decreases in the natural hydrogen ion concentration (pH). Rapid changes in the pH of the stream water can have adverse effects on fish, particularly if the hydrogen ion concentration is reduced such that the pH reading increases above nine.

Direct injury or mortality resulting from equipment use and dewatering activities. During instream construction activities, fish species may be crushed by earth moving equipment, construction debris, and worker foot traffic. It is therefore necessary to isolate the work area from actively flowing water through the use of coffer dams and dewatering pumps. However, dewatering activities can lead to fish becoming concentrated or stranded in residual wetted areas. Thus, if coho salmon and CDFG fish species of special concern are known to or assumed to occur in the project area, capture and relocation procedures need to be implemented prior to construction. Capture and relocation efforts, in turn, may also result in injury or mortality to fish if not conducted by a qualified biologist according to established guidelines.

Temporary loss, alteration, or reduction of habitat. In-channel construction activities, the use of construction equipment in stream channels, workspace dewatering, and clearing of riparian vegetation for work site access may result in temporary impacts to the habitat of coho salmon and CDFG fish species of special concern. Potential adverse impacts that may occur include alterations of the stream substrate composition and channel integrity. Riparian vegetation is an important component of coho salmon habitat, providing channel shading, bank stability and complexity, instream cover in the form of LWD, and an important source of organic matter and food. The temporary loss of riparian vegetation may result in increased soil erosion, elevated water temperatures, and loss of fisheries habitat complexity.

Mitigation Measures Proposed as Part of the Program

Mitigation Measure 3.3-1a: Implementation of ITP General Conditions (g) Instream work period, (h) Instream equipment work period, and (i) Compliance with Fish and Game Code, § 1600 *et seq.* (Article XIII.E.1) would avoid or minimize potential direct and indirect impacts to coho salmon and CDFG fish species of special concern resulting from instream construction and maintenance activities.

Mitigation Measure 3.3-1b: Implementation of numerous applicable conditions in the MLTC would further avoid or minimize potential direct and indirect impacts to coho salmon and CDFG fish species of special concern resulting from instream and upland construction and maintenance activities.

Mitigation Measures Identified in this Draft EIR

Mitigation Measure 3.3-1c: ITP General Conditions (g) and (h) (Article XIII.E.1) limit the season for instream equipment operations and work related to structural restoration projects to the period from July 1 to October 31. Similarly, ITP Additional Avoidance and Minimization Measure D (Livestock and Vehicle Crossings) (Article XV.D) and conditions in the MLTC limit the use of stream crossings to the same period. However, based on documented adult coho salmon migration timing in the Shasta River (Hampton, 2006), coho salmon may enter the Shasta River prior to October 31. Furthermore, the Chinook salmon spawning season occurs even earlier in the season, depending on streamflows. Therefore, as specified under Mitigation Measure 3.2-1d (Chapter 3.2 Geomorphology, Hydrology, and Water Quality) the season for instream construction activities, equipment operations, and stream crossing utilization shall be limited to the period of July 1 through October 15. If weather conditions permit and the stream is dry or at its lowest flow, instream construction activities and equipment operations may continue after October 15, provided a written request is made to CDFG at least five days before the proposed work period variance. Written approval from CDFG for the proposed work period variance must be received by SVRCD or Agricultural Operator prior to the start or continuation of work after October 15.

If work is performed after October 15 as provided above, SVRCD or Agricultural Operator will do all of the following:

- Monitor the 72 hour forecast from the National Weather Service. When there is a forecast of more than 30 percent chance of rain, or at the onset of any precipitation, the work shall cease.
- Stage erosion and sediment control materials at the work site. When there is a forecast of more than 30 percent chance of rain, or at the onset of any precipitation, implement erosion and sediment control measures.

Level of Significance after Mitigation

Implementation of the Program, including the mitigation measure discussed above, would reduce potential impacts of construction, maintenance, and other instream activities to coho salmon and CDFG fish species of special concern and their habitat to a less-than-significant level.

Impact 3.3-2: Increased extraction of groundwater could contribute to decreased baseflows and increased ambient water temperatures in the Shasta River and its tributaries, thereby impacting coldwater fish habitat (Less than Significant).

As part of the Program, groundwater may be utilized in place of surface water supplies. In particular, under ITP Mitigation Obligations of SVRCD (a)(iv) (Article XIII.E.2) groundwater supplies may be used as one alternative means of satisfying stock water demands from October through December (the other alternatives being off-stream storage or other appropriate methods). This measure is intended to enhance surface flows during dry conditions and during critical times of the year (October through December) in order to improve salmonid habitat.

However, as discussed in Impact 3.2-5 in Chapter 3.2, increased use of groundwater during dry conditions in order to curb the consumptive use of surface water, as proposed by the Program, could decrease groundwater discharge into the Shasta River and its tributaries. A reduction in groundwater discharge could decrease base flow volumes and could contribute to increased water temperatures. Groundwater and subsurface flow contribute cool water, directly and indirectly (i.e., by means of spring and seep maintenance), to surface stream channels in the Program Area. As shown by NCRWQCB (2006), spring flow input can dramatically reduce the ambient water temperature within the mainstem Shasta River. However, due to the complex geology that makes up the Shasta Valley groundwater basin, the inter-relationship between groundwater and surface water in the Program Area is still not well understood. During low flow conditions, if groundwater is pumped in proximity of a flowing stream or a subsurface channel such that subterranean flow is impacted, then that groundwater extraction could result in a decrease in instream flow and, concomitantly, an increase in water temperatures in the nearby stream.

Notwithstanding the above, any increase in groundwater use under the Program is expected to be low for the following reasons: 1) the proposed scale of the alternative stock watering system is small; the Program specifies the installation of two systems per year within the entire Program Area; 2) not all such systems would necessarily use groundwater, as alternative methods are also proposed; 3) groundwater irrigation tends to cost more (for well installation, piping, and power costs); and 4) the availability of groundwater resources in the Shasta Valley varies greatly from location to location. As to the latter, in the northern portion of the Valley where the majority of irrigated lands exist, groundwater resources are more scarce compared to areas within the eastern portion of the Valley that overlie the more productive basalt formations.

Because it is not likely that the Program would cause a substantial increase in the use of groundwater, the level of any impacts associated with such use would be low. Further, for the season in which this system is proposed for use, October through December, the *volume* of streamflow is more of a concern for salmonid habitat than the temperature of the water. High water temperatures are of principal concern and exert more influence on limiting salmonid habitat in the late spring and summer months. In addition, some Agricultural Operators must divert much more surface water than is needed to satisfy their stock-watering needs, because a higher volume of water is necessary to enable water to flow from the point of diversion to the point of use to accommodate for carriage loss due to varying delivery efficiencies. Hence, in some cases, substitution of groundwater for surface water would result in a substantial reduction in the amount of water diverted.

As such, with respect to the impact that alternative stock watering systems may have on surface water temperatures, and thus fisheries and aquatic habitat, this potential impact is less than significant.

Mitigation Measures Identified in this Report

This potential impact was determined to be less than significant. No mitigation measures required.

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